The Goldiei group of rainbowfishes (Melanotaeniidae) from the Birds Neck Region of New Guinea (Papua and West Papua Provinces, Indonesia) with descriptions of five new species and recognition of *Melanotaenia dumasi* Weber

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Abstract

Genetic investigations reveal the closely-related "Goldiei" group of melanotaeniids from the Birds Neck region of western New Guinea contains at least six species, including five new taxa, which are described herein. Members of this group share a wide range of morphological and meristic features and lack notable differences, although discrepancies in modal or average values are sometimes useful. Due to their great similarity, the species in this group are most reliably distinguished on the basis of genetic differences and their allopatric geographic distributions. Three of the new species, including *M. bowmani*, *M. grunwaldi*, and *M. mamahensis*, represent the first descriptions of this southern New Guinea lineage from northern drainages. The ancestral species possibly colonised northward via the Omba-Woromi corridor, a low elevation (to 160 m) area linking the respective southern and northern drainages. The remaining three species, including the previously described *M. dumasi* Weber (previously considered a synonym of *M. goldiei)* from the Yamur Lake area and two new taxa, *M. etnaensis* and *M. lacunosa* from the vicinity of Etna Bay, inhabit southern drainages.

Zusammenfassung

Genetische Untersuchungen bestätigen, dass die nahe verwandten Arten der „Goldiei-Gruppe" unter den Melanotaeniiden der Birds-Neck-Gegend West-Neuguineas aus mindestens sechs Arten bestehen, darunter fünf neue Taxa, die hier erstmals beschrieben werden. Die Vertreter dieser Gruppe haben viele morphologische und meristische Merkmale gemeinsam, die Unterschiede sind gering, wenn es auch bei den Modal- und Durchschnittswerten einige hilfreiche Abweichungen gibt. Wegen der starken Ähnlichkeit lassen sich die Arten dieser Gruppe am zuverlässigsten auf der Grundlage genetischer Unterschiede und der allopatrischen geografischen Verteilung unterscheiden. Drei der neuen Arten: *M. bowmani, M. grunwaldi* und *M. mamahensis,* bilden die ersten Beschreibungen dieser südlichen Entwicklungslinie Neuguineas aus nördlichen Einzugsgebieten. Die Ursprungsarten drangen wahrscheinlich über den Omba-Woromi-Korridor nach Norden vor, einer niedrigen Erhebung (bis 160 m), die südliche und nördliche Einzugsgebiete verbindet. Die übrigen drei Arten: die schon vorher beschriebene Art *M. dumasi* Weber (ursprünglich als Synonym zu *M. goldiei* aufgefasst) von der Gegend des Yamur-Sees sowie zwei neue Taxa, *M. etnaensis* und *M. lacunosa* aus der Nähe der Etna-Bucht bewohnen südliche Einzugsgebiete.

Résumé

Des recherches génétiques révèlent que le groupe « Goldiei » d'espèces très voisines parmi les Mélanotaeniidés de la région du Birds Neck de l'ouest de la Nouvelle-Guinée compte au moins six espèces, comprenant cinq nouveaux taxons, qui sont décrites ici. Les membres de ce groupe partagent beaucoup de caractéristiques morphologiques et méristiques et ne présentent pas de différences notables, même si des divergences en valeurs modales ou moyennes sont parfois utiles. A cause de leur grande similarité, les espèces de ce groupe sont le plus fiablement distinguées sur base de différences génétiques et de leurs distributions géographiques allopatriques. Trois des nouvelles espèces, comprenant *M. bowmani, M. grunwaldi* et *M. mamahensis,* représentent la première description de ce lignage de Nouvelle-Guinée méridionale, issus de drainages du nord. Les espèces ancestrales ont peut-être émigré vers le nord par le

corridor Omba-Woromi, une aire peu élevée (jusqu'à 160 mètres) reliant les drainages du sud et du nord. Les trois espèces restantes, y compris *M. dumasi* Weber décrit précédemment (et considéré autrefois comme synonyme de *M. goldiei)* de la région du lac Yamur, et deux nouveaux taxons, *M. etnaensis* et *M. lacunosa*, non loin d'Etna Bay, peuplent des drainages méridionaux.

Sommario

Indagini genetiche rivelano come il gruppo di specie "Goldiei" dei Melanotaeniidae dalla regione Birds Neck della Nuova Guinea occidentale sia strettamente imparentato; il gruppo contiene almeno sei specie, di cui cinque nuovi taxa, che sono descritti nel presente articolo. I membri di questo gruppo condividono una vasta gamma di caratteristiche morfologiche e meristiche e non presentano importanti difformità, anche se le differenze nei valori modali o medi sono a volte utili. Grazie alla loro grande somiglianza, le specie di questo gruppo si distinguono in modo più affidabile sulla base delle differenze genetiche e sulla loro distribuzione geografica allopatrica. Tre delle nuove specie, tra cui *M. bowmani, M. grunwaldi* e *M. mamahensis* rappresentano la prima descrizione in bacini settentrionali di questa discendenza tipica della Nuova Guinea meridionale. Le specie ancestrali hanno probabilmente colonizzato il nord attraverso il corridoio Omba-Woromi, un'altura (a 160 m) che collega i rispettivi drenaggi meridionali e settentrionali. Le restanti tre specie, compresa la specie *M. dumasi* Weber (prima considerata sinonimo di *M. goldiei)* dalla zona del lago Yamur e due nuovi taxa, *M. etnaensis* e *M. lacunosa* dalle vicinanze di Etna Bay, abitano bacini meridionali.

INTRODUCTION

Rainbowfishes of the family Melanotaeniidae are common in freshwaters of the New Guinea-Australia region with nearly 100 valid species reported to date (Eschmeyer 2015). Despite this impressive total, there are many additional new species that require description, comprised of both new discoveries and existing species that were formerly considered as widespread, but on the basis of genetic studies are actually composed of multiple taxa. In the latter category the "Goldiei" group of *Melanotaenia* has a particular propensity for speciation, more than any other group of rainbowfishes studied to date (Unmack et al. 2013). The nominal *Melanotaenia goldiei* (Macleay 1883) was originally described from the Goldie River near Port Moresby, Papua New Guinea, but subsequent collections throughout southern New Guinea extended the

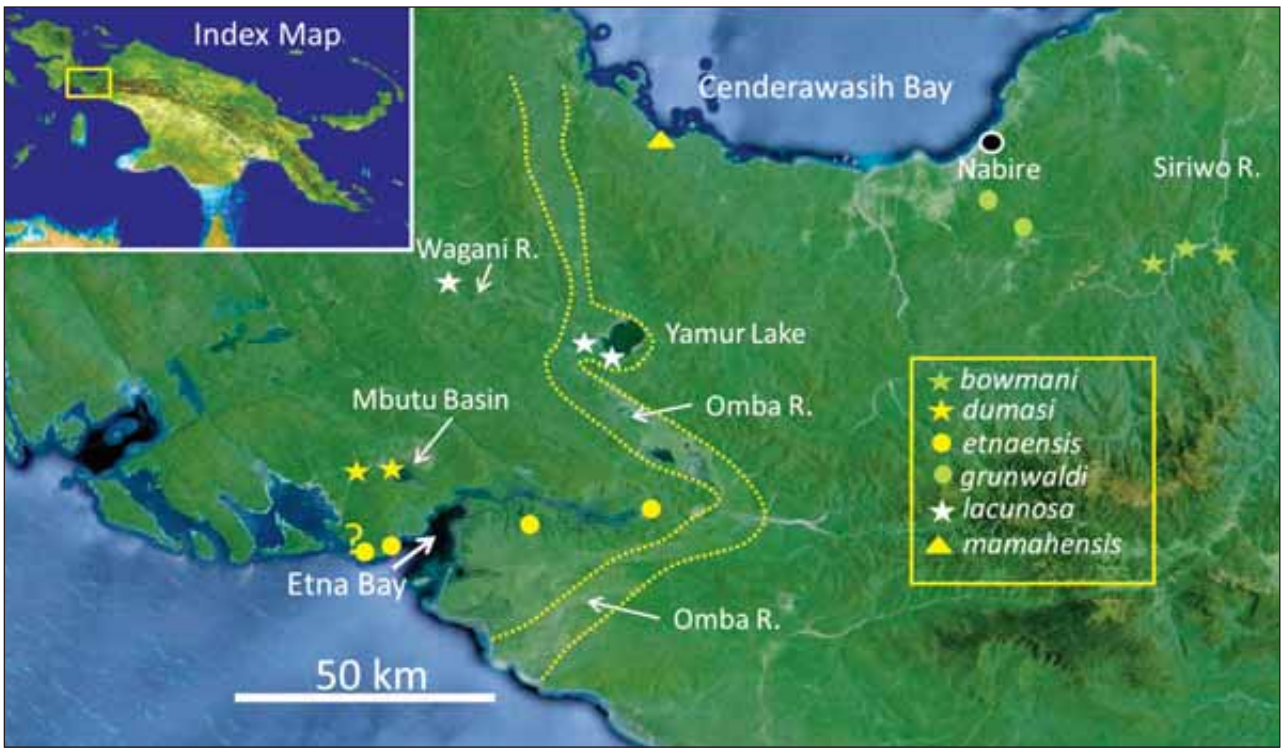

Fig. 1. Map of Birds Neck region of western New Guinea (West Papua Province, Indonesia) showing distribution of western "Goldiei" group of *Melanotaenia* species. The yellow dotted line indicates the approximate boundary of the Omba-Woromi "corridor" as discussed in the text. The question mark indicates fish has been provisionally identified as *M. etnaensis* on the basis of photographs.

range 1,500 km westward to the Etna Bay area of West Papua (Allen 1995). However, recent genetic investigations (Unmack et al. 2013, Allen et al. 2015) reveal at least 13 genetically distinct populations, most of which are deserving of specific recognition. In addition, the closely related *M. trifasciata* (Rendahl 1922) of northern Australia is divisible into several species (Unmack et al. 2013). This family and especially the "Goldiei" group is particularly prone to speciation events when populations are fragmented by marine incursions or various geological processes such as stream capture, lake formation, and tectonic plate movements. For example, repeated sea-level changes and subsequent isolation of insular populations at the Aru Islands are likely responsible for the evolution of four closely-related species (Allen et al. 2015). Similarly, landslides with subsequent lake formation and other upstream barriers such as high waterfalls and stream capture events are probably responsible for the presence of four species of the "Goldiei" group

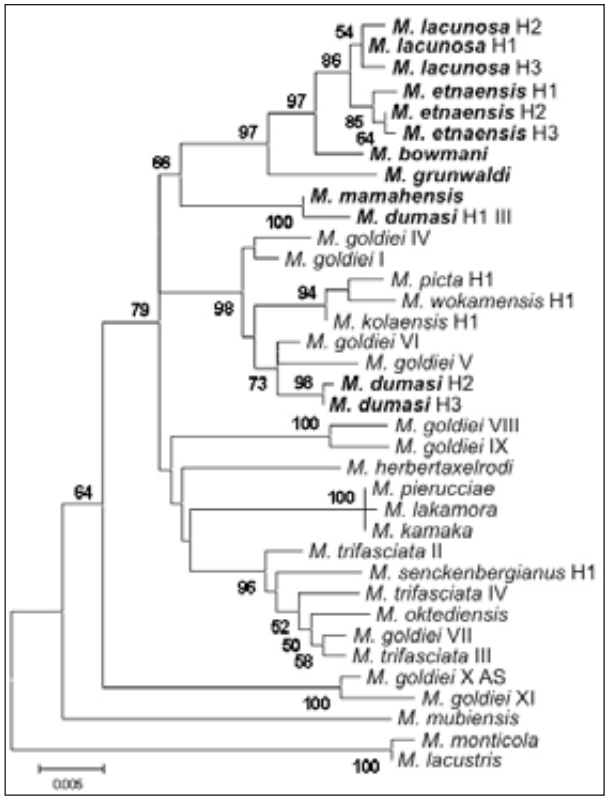

Fig. 2. Maximum likelihood tree for members of the "Goldiei" group based on analysis of cytochrome *b* sequences. New or elevated species based on the current study are shown in bold. Bootstrap values were obtained from 1,000 replicates, only values above 50 are shown. See Table 1 for locality and haplotype details.

in the Kikori River system of Papua New Guinea (Allen et al. 2015).

The present paper investigates additional members of the "Goldiei" group, which occur near the western limit of distribution in the "Birds Neck" region of New Guinea (West Papua Province, Indonesia). Coverage is provided for six species, including five new taxa. *Melanotaenia dumasi* Weber 1907 from the vicinity of Lake Yamur is the only previously described member of the group and was formerly considered as a junior synonym of *M. goldiei* (Allen & Cross 1982). Typical of many rainbowfish species, the Birds Neck taxa are similar in general appearance and exhibit largely overlapping counts and proportional measurements. They are characterized by a mid-lateral dark stripe, narrow reddish stripes between scale rows that are most evident on the back, and a small reddish spot on the upper opercle. Like most rainbowfishes, males gradually develop a relatively deep body (maximum depth about 34-37 % of SL in adults) compared to females (maximum depth about 28-31 % of SL in adults) and further differ in having a longer first dorsal fin (noticeably overlapping second dorsal if adpressed) and a longer, more pointed second dorsal-fin profile. Due to their similarity the various Birds Neck species treated here are best separated on the basis of their allopatric distributions (Fig. 1), colouration, and DNA sequence results (Fig. 2).

Curiously, this study documents the presence of three new species from the northern coast of New Guinea, contrary to previous reports indicative of an exclusively southern New Guinea distribution for the "Goldiei" group (Allen & Cross 1982; Allen, 1995). However, the northward spread is not totally unexpected in view of the short distance (about 65 km) separating Etna Bay in the south and Cenderawasih Bay in the north and the potential dispersal route via the low-lying (maximum altitude about 160 m) Omba-Woromi corridor (Fig. 1), which is discussed at the end of the paper.

MATERIALS AND METHODS

Counts and measurements that appear in parentheses refer to the range for paratypes if different from the holotype. Type specimens are deposited at the Museum of Natural History (Naturalis), Leiden (RMNH), Museum Zoologicum Bogoriense, Cibinong, Java, Indonesia (MZB), National Museum of Natural History, Washington, D.C. (USNM), and Western Australian Museum, Perth (WAM). The holotype of *Rhombatractus dumasi*

Table I. Rainbowfish species from the "Goldiei" group used in the phylogenetic analysis including locality data, the number of individuals examined, GenBank accession number for each unique haplotype and the number of individuals with each haplotype. The first eight rows represent new sequences, the remaining samples are from Unmack et al. (2013) and Allen et al. (2015). For locality data, AS=aquarium strain, IND=Indonesia, PNG=Papua New Guinea, NT=Northern Territory, QLD=Queensland, the latter two being from Australia.

Species	Locality (site #)	N	GenBank #	Haplotype(# of fish)
M. bowmani	Siriwo River, IND	1	KT334405	
M. dumasi	Lake Yamur, IND	8	H1=KC133568.1 H2=KT334408 H3=KT334409	H1(1), H2(3), H3(4)
M. etnaensis	Sungai Pama, IND	2	H1=KT334401	H1(1), H3(1)
M. etnaensis	Sungai Ambalanga, IND	7	H2=KT334399 H3=KT334400	H2(1), H3(6)
M. grunwaldi	Topo River, IND	4	KT334407	
M. lacunosa	stream 8 km from Kayu Merah, IND	2	H1=KT334402 H2=KT334403	H1(1), H2(1)
M. lacunosa	trib. to Danau Mbuta, IND	4	H3=KT334404	H1(3), H3(1)
M. mamahensis	Sungai Mamah, IND	2	KT334406	
M. goldiei I	Sungai Loramar, Aru Is., IND		KC133569.1	
M. goldiei IV	Timika, IND		KC133565.1	
M. goldiei V	Timika, IND		KC133572.1	
M. goldiei VI	Pulau R, IND		KC133573.1	
M. goldiei VII	Fly R, PNG		KC133585.1	
M. goldiei VIII	Kikori R, PNG		KC133566.1	
M. goldiei IX	Lakekamu R, PNG		KC133570.1	
M. goldiei X	AS, Angabunga R, PNG		KC133571.1	
M. goldiei XI	Laloki R, PNG		KC133564.1	
M. herbertaxelrodi	AS, L Tebera, PNG		KC133574.1	
M. kamaka	L Kamakawaiar, IND		KC133575.1	
M. kolaensis	Sungai Kofukim, Aru Is., IND		KP345839.1	
M. lacustris	AS, L. Kutubu, PNG		KC133576.1	
M. lakamora	L Lakamora, IND		KC133577.1	
M. monticola	Purari R, PNG		KC133578.1	
M. mubiensis	Kikori R, PNG		KC133579.1	
M. oktediensis	Fly R, PNG		KC133580.1	
M. picta	Sungai Gora, Aru Is., IND		KP345842.1	
M. pierucciae	trib to L Kamakawaiar, IND		KC133581.1	
M. senckenbergianus	Sungai Galalou, Aru Is., IND		KP345849.1	
M. trifasciata II	Blyth R, NT		KC133584.1	
M. trifasciata III	Wenlock R, QLD		KC133583.1	
M. trifasciata IV	Gap Ck, QLD		KC133582.1	
M. wokamensis	Sungai Gaibel, Aru Is., IND		KP345840.1	

was examined at the Zoologisch Museum, Amsterdam (ZMA, now housed at RMNH).

The methods of counting and measuring follow those of Allen & Cross (1982): dorsal and anal rays – the last ray of the anal and second dorsal fins is divided at the base and counted as a single ray; lateral scales – number of scales in horizontal row from upper edge of pectoral-fin base to caudal-fin base, excluding the small scales posterior to the hypural junction; transverse scales – number of scales in vertical row between anal fin origin and base of first dorsal fin; predorsal scales – number of scales along midline of nape in front of first dorsal fin; cheek scales – total number of scales covering the suborbital and preoperculum; total gill rakers includes all elements, including 2-3 small rakers on

Table II. Summary of selected fin ray, gill raker, and scale counts for "Goldiei" group of species from the Birds Neck region of New Guinea. Asterisk (*) indicates that counts were recorded on both sides of the same individual.

	1st Dorsal spines		2nd Dorsal soft rays					
Species	V	VI	12	13	14	15	16	Avg.
M. bowmani	3	2	1		1	3		14.2
M. dumasi	9	3	1	3	3	5		14.0
M. etnaensis	15	11		11	12	3		13.7
M. grunwaldi	7	4	9	2				12.2
M. lacunosa	7	10		5	5	6	1	14.1
M. mamahensis	7	2	1	3	3	2		13.6

Anal soft rays

Species	19	20	21	22	23	24	25	Avg.
M. bowmani			1	3	1			22.0
M. dumasi			2	2	5	3		22.8
M. etnaensis			2	3	8	8	5	23.4
M. grunwaldi		1	6	3	1			21.4
M. lacunosa			2	6	5	4		22.6
M. mamahensis			4	5				21.5

Pectoral rays

Species	13	14	15	16	Avg.
*M. bowmani**	1	6	3		14.2
M. dumasi		4	8		14.7
M. etnaensis	1	13	12		14.4
*M. grunwaldi**	2	15	5		14.1
M. lacunosa		4	9	4	15.0
M. mamahensis	3	5	1		13.8

Cheek scales

Species	16	17	18	19	20	21	22+	Avg.
M. bowmani			1		1	2	1	20.4
M. dumasi		1	2	2	2	4	2	20.1
M. etnaensis	1	1	4	4	7	3	3	19.6
M. grunwaldi	2	1	2	2	1	2	1	18.8
M. lacunosa	1	7	1	3				17.5
M. mamahensis	5	3	1					16.6

Total gill rakers

Species	12	13	14	15	16	17	Avg.
*M. bowmani**				3	2		15.4
M. dumasi				6			15.0
M. etnaensis				9	4		15.3
*M. grunwaldi**				2	7	2	16.0
M. lacunosa	1	3	10	3			13.9
*M. mamahensis**			1	1	7		15.7

Prepelvic scales

Species	14	15	16	17	18	19	20	Avg.
M. bowmani	1	1	2		1			15.8
M. dumasi				3	2		1	17.8
M. etnaensis		1	5	7	1	2	1	17.1
M. grunwaldi	1		2	8				16.5
M. lacunosa			5	1				16.2
M. mamahensis	5	2	2					14.6

the upper arch, 1-2 of which are usually embedded in a protuberance of fatty tissue; standard length (SL) – measured from the tip of the upper lip to the caudal-fin base; head length (HL) – measured from the tip of the upper lip to the upper rear edge of the gill opening; caudal peduncle depth is the least depth and caudal peduncle length is measured between two vertical lines, one passing through the base of the last anal ray and the other through the caudal-fin base; caudal concavity is the horizontal distance between verticals at the tips of the shortest and longest rays.

All of the rainbowfish sequences from the monophyletic "Goldiei" group species within the Southern lineage included by Unmack et al. (2013) were analysed, plus new sequences obtained from the Birds Neck region species (Table I). We sequenced the mitochondrial cytochrome *b* (cyt*b*) gene and used GARLI 2.0 (Zwickl 2006) to obtain the best Maximum Likelihood tree and 1000 bootstrap replicates. Methods for obtaining and analysing DNA sequence data follows Allen & Unmack (2012) and Allen et al. (2014) except: the model of sequence evolution TrN+I was the best one identified by ModelTest 3.7 (Posada & Crandall, 1998), we used attachments per taxon = 74, and trees were rooted with *M. lacustris* and *M. monticola*. GenBank accession numbers are provided in Table I for all new sequences obtained in this study.

Melanotaeniid taxonomic features: Allen (1980) provided a generic classification of rainbowfishes based largely on certain osteological structures, particularly those related to the jaw, pelvic and pectoral girdles, and caudal-fin skeleton. However, species-level differences are generally based on traditional morphometric and meristic data. Some of the most useful meristic features (Table II) include counts of dorsal, anal, and pectoral fin rays, as well as the number of lateral and transverse scale rows on the body and number of scales covering various regions of the head and body including the cheek (preopercle), predorsal and prepelvic midline, and around the caudal peduncle. Total number of gill rakers on the first branchial arch, although occasionally useful, is generally of lesser value. The members of the "Goldiei" group included in this study share a wide range of morphological and meristic features and lack notable differences, as would be expected for closely related sister taxa. However, discrepancies in modal or average values are sometimes useful. Due to their great similarity, the species belonging to the Birds Neck "Goldiei" group are most reliably distinguished on the basis of genetic differences, colouration, and their allopatric geographic distributions. Melanotaeniids exhibit considerable allometric and sex-related variation. Therefore, it is especially important to make comparisons of similar-sized individuals of the same sex when assessing interspecific differences. In addition, the small number of individuals for some new taxa described herein precludes a proper assessment of their reliability. Adult males are usually deeper bodied than females and have a more elongate, pointed shape posteriorly on the soft dorsal and anal fins. The longest soft dorsal-fin rays of males are located in the posteriormost portion of the fin, and those of females are situated in the anterior half of the fin. The first dorsal fin of males is also much taller than that of females, the longest spine usually reaching well beyond the origin of the second dorsal fin when adpressed. Although many species become sexually mature at sizes below 45 mm SL, adults of the "Goldiei" group greater than about 60 mm SL are the most useful for showing differences in colour pattern and sex-related proportional differences.

SYSTEMATICS

Melanotaenia bowmani, n. sp.

Bowman's Rainbowfish
(Figs 3-4; Tables II-III)

Holotype: MZB 22775, male, 61.1 mm SL, small creek at junction with Siriwo River, 03° 30.705'S, 135° 52.271'E, Papua Province, Indonesia, seine net, J. Graf & G. Lange, 12 August 2012.

Paratypes (collected with holotype): MZB 22776, 2 specimens, 61.0-64.7 mm SL; WAM P.34394-001, 2 specimens, 66.1-69.4 mm SL.

Diagnosis: A species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays V or VI-I,12 -15 (usually 15); anal rays I,21-23; pectoral rays 13-15 (usually 14); lateral scales 34-36 (usually 34-35), predorsal scales 16; cheek scales 17-23, including 2-4 scales on preorbital; total gill rakers on first arch 15-16; greater average caudal-peduncle depth (11.9 % of SL, vs. 10.6-11.5 %) and longer average caudal-peduncle length (16.1 % of SL, vs. 14.5-15.7 %) compared to other Birds Head members of the "Goldie" group; colour of adult male in life golden brown dorsally on head and body, whitish on ventral portions and blackish midlateral stripe from

eye to caudal-fin base, usually faint on anterior and middle section of body, but prominent posteriorly; bluish zone anteriorly on lower side beginning at level of lower pectoral-fin base, extending posteriorly to above anterior part of anal fin, merging with diffuse greyish area that extends nearly to beginning of lower caudal peduncle; first dorsal fin bluish anteriorly, grading to dusky yellow posteriorly; second dorsal and anal fins yellow basally and mainly translucent on outer half, except middle part of anterior half of second dorsal turquoise; caudal fin semi-translucent greyish; pelvic fins white.

Description: Dorsal rays VI-I,14 (V or VI-I,15, except one paratype with 12); anal rays I,22 (I,21-23); pectoral rays 14 (13 to 15); pelvic rays I,5; branched caudal rays 15; procurrent caudal rays 6 + 6 (6-7 + 6); lateral scales 35 (34-36); transverse scales 10; predorsal scales 16; prepelvic scales 14 (15-18); cheek scales 21 (17-23), including 3 (2-4) scales on preorbital; circumpeduncular scales 12 (13, except one paratype with 14); total gill rakers on first arch 16 (15-16).

Body depth 2.9 (2.8-3.0) in SL; HL 3.7 (3.6-3.8) in SL; greatest width of body 2.5 (2.1-2.6) in greatest body depth; snout length 3.1 (2.9-3.5) in HL; eye diameter 3.0 (3.0-3.3) in HL; interorbital width 2.6 (2.3-2.7) in HL; depth of caudal pedun-

Fig. 3. Aquarium photographs of *Melanotaenia bowmani*, adult male (upper) and female, approximately 80 and 60 mm SL respectively, Siriwo River, Papua Province, Indonesia. Photo by G. Lange.

Table III. Proportional measurements of type specimens of *Melanotaenia bowmani* expressed as percentage of the standard length.

	Holotype MZB 22775	Paratype WAM P.34394	Paratype WAM P.34394	Paratype MZB 22776	Paratype MZB 22776
Sex	male	male	male	male	male
Standard length (mm)	61.1	69.4	66.1	64.7	61.0
Body depth	34.7	33.4	36.1	35.9	33.7
Body width	13.7	15.9	13.7	14.7	14.0
Head length	26.8	26.7	26.6	28.1	27.9
Snout length	8.8	9.1	9.3	9.7	8.0
Eye diameter	9.0	8.1	8.9	9.2	9.4
Maxillary length	8.8	8.7	9.3	8.7	8.5
Bony interorbital width	10.3	10.0	10.9	12.1	10.3
Depth of caudal peduncle	11.5	11.4	12.6	12.0	11.9
Length of caudal peduncle	16.5	17.5	14.8	15.8	16.0
Predorsal distance	48.0	47.0	47.5	48.3	48.7
Preanal distance	49.8	49.9	47.7	52.2	48.1
Prepelvic distance	38.9	37.2	36.8	38.7	36.4
2nd dorsal-fin base	26.2	27.1	28.9	26.5	25.0
Anal-fin base	41.3	39.5	43.4	36.8	38.9
Pectoral-fin length	19.6	19.9	19.2	18.9	18.9
Pelvic-fin length	15.8	16.3	17.0	16.1	15.8
Longest ray 1st dorsal fin	19.1	18.9	17.0	14.5	16.7
Longest ray 2nd dorsal fin	14.2	14.7	15.0	12.8	15.0
Longest anal ray	13.0	14.2	13.8	13.5	11.7
Caudal-fin length	22.4	22.3	22.1	24.5	22.5
Caudal concavity	5.6	5.6	6.6	7.3	5.5

cle 2.3 (2.1-2.3) in HL; length of caudal peduncle 1.6 (1.5-1.8) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends almost below anterior edge of eye; maxillary length 3.0 (2.9-3.3) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 9-10 irregular rows anteriorly, reduced to single row posteriorly where exposed when mouth closed; teeth in lower jaw in about 7-10 irregular rows anteriorly, reduced to 1 or 2 rows posteriorly;

Fig. 4. Preserved holotype of *Melanotaenia bowmani*, male, 61.1mm SL, Siriwo River, Papua Province, Indonesia. Photo by G. R. Allen.

vomerine teeth poorly developed, usually a few small teeth in narrow row; palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; row of small, truncated scales along bases of dorsal and anal fins; no scales on membranous portions of fins except several rows of small scales basally on caudal fin and triangular scale patch medially between base of pelvic fins; scale margins weakly crenulate; predorsal scales extending forward to about middle of interorbital space; preopercle with 2-3 scale rows between its posterior angle and eye.

Predorsal length 2.1 in SL; preanal length 2.0 (1.9-2.0) in SL; prepelvic length 2.6 (2.6-2.7) in SL; length of second-dorsal fin base 3.8 (3.5-4.0); length of anal-fin base 2.4 (2.3-2.7).

First dorsal fin origin about level with anal fin origin; longest spine (usually third) of first dorsal fin 1.4 (1.4-1.9) in HL, its depressed tip reaching to base of second or third soft ray of second dorsal fin; longest rays (generally middle to posterior ones) of second dorsal fin 1.9 (1.8-2.2) in HL, adpressed posterior rays extending about two thirds to entire length of caudal peduncle in male type specimens; longest (middle) anal rays 2.1 (1.9-2.4) in HL; pelvic fin tips when adpressed reaching to base of second or third soft anal-fin ray in male type specimens; length of pelvic fins 1.7 (1.6-1.8); length of pectoral fins 1.4 (1.3-1.5) in HL; length of caudal fin 1.2 (1.1-1.2) in HL; caudal fin moderately forked, caudal concavity 4.8 (3.8-5.0) in HL.

Colour in life (Fig. 3): adult male golden brown dorsally on head and body, whitish on ventral portions; blackish midlateral stripe from eye to caudal-fin base, usually faint on anterior and middle section of body, but prominent posteriorly, widest portion on caudal peduncle where it covers 1.5-2 horizontal scale rows; narrow bronze-coloured stripe between each scale row on upper half of side; 1-2 scale rows above dark midlateral stripe and row below it mainly pale grey or whitish, except row below with broad yellow-orange scale margins on posterior third of body; bluish zone anteriorly on lower side beginning at level of lower pectoral-fin base, extending posteriorly to above anterior part of anal fin, merging with diffuse greyish area that extends nearly to beginning of lower caudal peduncle, also numerous pepper-like melanophores overlying lowermost 2-3 scales rows on side; upper portion of opercle silvery with red

Fig. 5. Type locality of *Melanotaenia bowmani* at Siriwo River, Papua Province, Indonesia. Photo by G. Lange.

spot (about one-half pupil size); diffuse brownish stripe from anterior edge of eye to upper jaw; first dorsal fin bluish anteriorly, grading to dusky yellow posteriorly; second dorsal and anal fins yellow basally and mainly translucent on outer half, except middle part of anterior half of second dorsal turquoise; caudal fin semi-translucent greyish; pelvic fins white; pectoral fins mainly translucent.

Colour in alcohol (Fig. 4): brown dorsally grading to light brown on breast and side of head, lower side of body dusky greyish with numerous pepper-like melanophores; blackish midlateral stripe from upper rear corner of eye to caudal-fin base; also distinct narrow, tan stripe on posterior half of body about one longitudinal scale row above dark midlateral stripe; fins mainly dusky greyish except pectorals and pelvics translucent whitish.

Comparisons: Adult males (Fig. 3, upper) have a relatively subdued pattern compared to most "Goldiei" group members from the Birds Neck region. In particular, the mid-lateral dark stripe is diffuse in the middle of the body and the narrow stripes between horizontal scale rows on the upper half of the side are bronze colour rather than reddish or orange in the other species. Compared to the other species it also has a greater average caudal-peduncle depth (11.9 % of SL, vs. 10.6-11.5 %) and longer average caudal-peduncle length (16.1 % of SL, vs. 14.5-15.7 %). This species also has the highest average number of cheek scales (20.4 vs. 16.8-20.1, Table II).

Zoogeography and habitat: The new species is currently known from at least two locations (Fig. 1) in the Siriwo River system of Papua Province, Indonesia. It was encountered at two bridge crossings along the Nabire-Enarotoli road, one at approximately 79 m (Fig. 5) and the other at 197 m above sea level. In both cases the fish occurred in moderately fast-flowing conditions over rocky bottoms. Temperature and pH values of 22°C and 6.5 respectively were recorded at the time of collection (August 2012).

Etymology: The new species is named *bowmani* in honour of Ron Bowman, a widely respected Australian aquarist, in recognition of his many years of rainbowfish breeding expertise and knowledge sharing as well as countless contributions and exemplary leadership in connection with the Australia New Guinea Fishes Association (ANGFA) and its journal *Fishes of Sahul*.

Melanotaenia dumasi Weber, 1907

Omba Rainbowfish
(Fig 6; Tables II & IV)

Melanotaenia dumasi Weber, 1907: 240, plate 11, figure 1 (Wagani River and Wa Udu River near Urama River, West Papua, Indonesia).

Fig. 6. Aquarium photograph of *Melanotaenia dumasi*, male, 86.6 mm SL (WAM P.31048-005), near Lake Yamur, West Papua Province, Indonesia. Photo by G. R. Allen.

Table IV. Proportional measurements of selected type specimens of *Melanotaenia etnaensis* expressed as percentage of the standard length.

	Holotype MZB 21763	Paratype WAM P.31302	Paratype MZB 22781	Paratype WAM P.31302	Paratype MZB 22781	Paratype WAM P.31302	Paratype MZB 22781	Paratype WAM P.31302
Sex	male	male	male	male	female	female	female	female
Standard length (mm)	99.8	96.0	89.1	82.8	92.7	83.2	79.6	65.7
Body depth	36.2	38.0	35.8	35.6	32.6	31.6	32.0	31.2
Body width	13.4	14.8	12.9	13.8	13.6	14.3	13.2	13.4
Head length	26.4	27.8	27.4	26.6	27.3	27.5	28.1	26.5
Snout length	9.6	9.7	9.8	10.0	8.6	9.5	9.4	9.3
Eye diameter	6.9	7.4	8.1	7.5	7.7	8.3	8.5	8.8
Maxillary length	9.3	9.5	9.8	9.4	8.1	9.5	8.9	9.3
Bony interorbital width	9.9	10.5	10.3	9.9	10.6	9.7	10.1	9.1
Depth of caudal peduncle	11.5	11.6	10.9	10.7	10.5	10.3	10.4	10.5
Length of caudal peduncle	12.9	12.7	14.5	16.2	15.3	14.7	13.8	15.1
Predorsal distance	48.6	50.9	49.7	49.5	51.1	49.6	49.2	48.6
Preanal distance	49.5	50.3	48.4	49.0	49.5	50.2	47.5	50.7
Prepelvic distance	36.9	37.1	35.9	36.8	38.1	38.3	36.7	37.0
2nd dorsal-fin base	26.8	26.8	26.7	24.2	24.4	23.6	25.3	24.2
Anal-fin base	44.0	45.2	45.8	42.3	41.9	41.7	44.1	40.2
Pectoral-fin length	18.0	18.5	20.8	18.6	20.2	19.8	20.6	19.0
Pelvic-fin length	19.5	21.8	19.0	17.0	17.7	18.3	16.5	17.2
Longest ray 1st dorsal fin	18.8	18.3	16.7	18.6	12.4	18.1	14.8	14.2
Longest ray 2nd dorsal fin	16.8	13.2	16.3	14.5	11.4	13.2	11.9	13.5
Longest anal ray	13.4	15.1	12.7	13.3	14.3	14.1	12.8	13.7
Caudal-fin length	19.7	24.2	20.4	23.3	22.3	22.8	22.2	21.6
Caudal concavity	4.9	6.3	5.3	5.6	6.4	7.9	6.5	7.3

Melanotaenia goldiei (non Macleay), Allen & Boeseman 1982:78 (Lake Yamur).

Material examined (all West Papua, Indonesia): RMNH 28422, 41 specimens, 16.0-78.9 mm SL, Lake Yamur; WAM P.31045-001, 6 specimens, 37.5-61.4 mm SL mm SL, Lake Yamur; WAM P.31048-005, 9 specimens, 34.6-86.6 mm SL, Lake Yamur; ZMA 103112 (lectotype of *Melanotaenia dumasi)*, 69.0 mm SL, Wa Udu River.

Diagnosis: A species of melanotaeniid distinguished by the following combination of characters: Dorsal rays V or VI-I,12-15; anal rays I,21-24 (rarely 24); pectoral rays 13-15 (rarely 13); lateral scale rows 35-37 (rarely 35); transverse scale rows 10-11; predorsal scales 16-17; prepelvic scales 17-20; circumpeduncular scales 14; preopercle-suborbital scales 17-23, including 1-3 scales on preorbital. Greatest body depth of adult male (82.0-86.6 mm

Fig. 7. Habitat of *Melanotaenia dumasi* near Lake Yamur, West Papua Province, Indonesia. Photo by G. R. Allen.

Fig. 8. Shoreline and surrounding hills at Lake Yamur, West Papua Province, Indonesia. Photo by G. R. Allen.

SL), 33.8-35.2 % SL; caudal peduncle depth 2.3-2.7 in HL; caudal peduncle length 1.7-2.0 in HL; predorsal distance 2.0-2.2 in SL; preanal distance 1.9-2.0 in SL; prepelvic distance 2.6-2.7 in SL.

Colour in life (Fig. 6): adult male greyish, frequently with coppery sheen on back, grading to whitish anteroventrally and blue posteroventrally; narrow orange stripe between horizontal scale rows on upper side; dark blue to blackish mid-lateral stripe from eye to caudal-fin base, widest portion on caudal peduncle, covering two horizontal scale rows; red-orange stripe immediately above and below dark mid-lateral stripe; upper portion of head blue brownish, lower half bluish white with silvery stripe behind eye extending across upper cheek and middle of operculum, usually punctuated posteriorly with small reddish spot; dorsal, anal, caudal fins translucent reddish; pelvic fins white; pectoral fins translucent. Colour pattern of female similar to that of male except less vivid and fins are mainly translucent, lacking reddish hue.

Colour in alcohol (Fig. 7): brown dorsally grading to tan on most of head and body; blackish stripe from upper rear corner of eye to side of body at level of pectoral fin, extending to base of caudal fin, anterior part of stripe about one scale wide, posterior part about two scales wide; fins mainly translucent whitish except anterior edge of first dorsal fin of larger males broadly dusky grey.

Comparisons: Adult males (Fig. 6) are distinguished by the bright orange-red stripe along the upper and lower margins of the dark mid-lateral stripe. This species also has the highest average number of prepelvic scales (17.8 vs. 14.8-17.1, Table II) and relatively high modal number of anal rays (22.8 vs. 21.3-23.4, Table II) compared to other members of the Birds Head "Goldiei" group. It also has the narrowest average interorbital width (9.8 % SL vs. 9.9-11.2 %).

Distribution and habitat: Known only from the Omba (Urama on some maps) river system of West Papua Province, Indonesia (Fig. 1), including streams in the vicinity of Lake Yamur (Fig. 7) where it is common in small creeks (Fig. 8) flowing into the main lake. Temperature and pH values recorded by the first author during July 1999 ranged from 24.4-26.0°C and 7.4-7.9 respectively. The physical aspects of Lake Yamur were described by Boeseman (1963).

Remarks: The holotype of *M. dumasi* was collected in August 1903 by the Netherlands New Guinea Expedition under the supervision of German geologist Arthur Wichmann (Hoedeman 1960, Frodin 2007). The type locality is the Wa Udu River, which is the main outflow from Lake Yamur, connecting it with the Omba River (formerly called the Urama), which lies about 7 km downstream. The Omba then follows a meandering, 165 km path to the Arafura Sea. The mouth is situated about 16 km southeast of Etna Bay. Three paratypes were obtained in 1909 during a reconnaissance of the Urama Basin led by Captain K.F. Koch, the Dutch military commander of the Western Detachment in New Guinea. These were collected from the Wagani River, a tributary of the Upper Urama, which is difficult to find on modern maps due to the incomplete nature and inaccuracies on the original Dutch charts. However, judging from a map of the area that appears in the 1903 expedition narrative (Weber 1907), it is probably very close to the location indicated in Fig. 1.

Melanotaenia etnaensis, n. sp.

Etna Bay Rainbowfish
(Figs 9-10; Tables II & IV)

Holotype. MZB 21763, male, 99.8 mm SL, Ambalanga River, 03°59.686'S, 134°34.464'E, West Papua Province, Indonesia seine net, R. Hadiaty & party, 9 December 2013.

Paratypes: MZB 22781, 42 specimens, 27.1-95.3 mm SL, collected with holotype; USNM 432432, 20 specimens, 35.8-83.4 mm SL, collected with holotype; WAM P.31302-001, 17 specimens, 40.5-95.5 mm SL, small creek at extreme eastern end of Etna Bay, 03°56.920`S, 134°58.568`E, West Papua Province, Indonesia, rotenone, G. Allen & K. Hortle, 30 April 1997.

Non-type specimens: WAM P.34395-001,5 specimens, 23.7-34.4 mm SL, Sungai Pama, 03°59.706`S, 134°47.727`, Etna Bay, West Papua Province, Indonesia, seine net, H. Bleher, 1 February 2013.

Diagnosis: A large (attains 100 mm SL, compared to about 62-90 mm SL for other Birds Head members of the "Goldiei group") species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays V or VI-I,13-15 (rarely 15); anal rays I,21-25 (usually 23-24); pectoral rays 13-15 (rarely 13); lateral scales 35-36; predorsal scales 15-18; cheek scales 16-22, including 2-3 scales on preorbital; total gill rakers on first arch 15-17; shortest average caudal-pedun-

cle length (14.5 % SL vs. 14.7-16.1 %) and highest average number of anal rays (23.4 vs. 21.3-22.8) compared to other Birds Neck members of the "Goldiei" group; colour of adult male in life generally bluish grey with narrow orange stripes between each longitudinal scale row, prominent blackish mid-lateral stripe from eye to caudal-fin base, large bluish patch on anteroventral portion of body, and mainly yellow to reddish dorsal and anal fins.

Description: Dorsal rays VI-I,14 (V or VI-I,13-15); anal rays I,24 (I,21-25); pectoral rays 15 (13-15); pelvic rays I,5; branched caudal rays 15; procurrent caudal rays 6 + 6 (5-6 + 5-7); lateral scales 36 (35-36); transverse scales 10; predorsal scales 17 (15-18); prepelvic scales 17 (15-19); cheek scales 21 (16-22), including 2 (2-3) scales on preorbital; circumpeduncular scales 14 (13-14); total gill rakers on first arch 16 (15-17).

Body depth 2.8 (2.6-3.8) in SL; HL 3.8 (3.5-3.8) in SL; greatest width of body 2.7 (2.2-2.8) in greatest body depth; snout length 2.8 (2.7-3.2) in HL; eye diameter 3.8 (2.9-3.7) in HL; interorbital width 2.7 (2.6-3.1) in HL; depth of caudal peduncle 2.3 (2.4-2.9) in HL; length of caudal peduncle 2.0 (1.6-2.1) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends almost below anterior edge of eye; maxillary length 2.9 (2.7-3.4) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 8-10 irregular rows anteriorly, reduced to single row posteriorly where exposed when mouth closed; teeth in lower jaw in about 7-11 irregular rows anteriorly, reduced to 1 or 2 rows posteriorly; vomerine teeth poorly developed in juvenile and

Fig. 9. Aquarium photographs of *Melanotaenia etnaensis*, adult male, (upper), approximately 100 mm SL and female, approximately 65 mm SL, Ambalanga River, Etna Bay, West Papua Province, Indonesia. Photos by G. R. Allen.

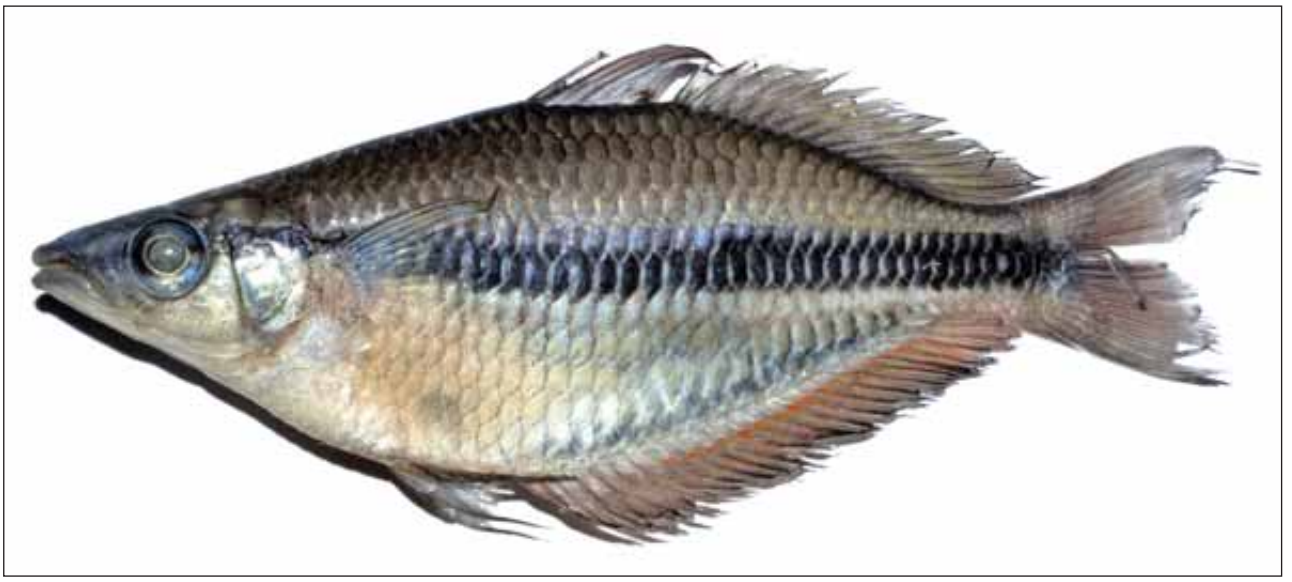

Fig. 10. Preserved holotype of *Melanotaenia etnaensis*, male, 99.8 mm SL, Amabalanga River, Etna Bay, West Papua Province, Indonesia. Photo by G. R. Allen.

Fig. 11. Type locality of *Melanotaenia etnaensis* at Ambalanga River, Etna Bay, West Papua Province, Indonesia. Photo by R. Hadiaty.

small adult, more conspicuous in large adult, consisting of narrow row; palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; row of small, truncated scales along bases of dorsal and anal fins; no scales on membranous portions of fins except several rows of small scales basally on caudal fin and triangular scale patch medially between base of pelvic fins; scale margins weakly crenulate; predorsal scales extending forward to about middle of interorbital space; preopercle with 2-3 scale rows between its posterior angle and eye.

Predorsal length 2.1 (1.9-2.1) in SL; preanal length 2.0 (1.9-2.1) in SL; prepelvic length 2.7 (2.6-2.8) in SL; length of second-dorsal fin base 3.7 (3.7-4.2); length of anal-fin base 2.3 (2.2-2.5).

First dorsal fin origin about level with anal fin origin; longest spines (usually third or fourth) of first dorsal fin 1.4 (1.4-2.2) in HL, its adpressed tip reaching spine of second dorsal fin or slightly beyond in female and to base of about third soft ray in adult male; longest rays (generally anterior ones in females and middle to posterior ones in males) of second dorsal fin 1.6 (1.7-2.4) in HL, adpressed posterior rays extending about one half length of caudal peduncle in females and full length of caudal peduncle or slightly beyond in mature males; longest (anterior to middle) anal rays 2.0 (1.8-2.5) in HL; pelvic fin tips when adpressed reaching to base of second or third soft anal fin ray in mature adults; length of pelvic fins 1.4 (1.4-1.8); length of pectoral fins 1.5 (1.3-1.5) in HL; length of caudal fin 1.3 (1.1-1.3) in HL; caudal fin moderately forked, caudal concavity 5.4 (3.1-5.2) in HL.

Colour in life (Fig. 9): bluish grey dorsally on head and back, ventral half of body with large bluish patch above pelvic fins and yellowish patch with blue-black scale margins on middle portion of lower side (above anterior half of anal fin), grading to tapering bluish area above posterior half of anal fin; conspicuous blackish mid-lateral stripe from eye to caudal-fin base, widest portion on posterior caudal peduncle where it covers about two horizontal scale rows; narrow orange stripe between each scale row on side of body (most conspicuous on upper side); longitudinal yellowish zone on side immediately below blackish mid-lateral stripe, most vivid on lower caudal peduncle; upper part of opercle (below black stripe) silvery, punctuated posteriorly with small red spot; first dorsal fin bluish; second dorsal and fins yellowish on basal half, translucent to reddish on outer half; caudal fin pale grey; pelvic fins pale yellowish; pectoral fins translucent. Colour pattern of female similar to that of male except generally less vivid.

Colour in alcohol (Fig. 10): brown dorsally grading to white or tan on most of head and lower half of body; blackish stripe from upper rear corner of eye to side of body at level of pectoral fin, extending mid-laterally to base of caudal fin, anterior part of stripe about one scale wide, posterior part about two scales wide; fins mainly translucent greyish, except pectorals translucent whitish.

Comparisons: The adult male (Fig. 9, upper & middle) is among the most colourful of the "Goldiei" group members from the Birds Neck region and grows to a very large size (100+ mm SL). Large males in particular exhibit a strong, well-contrasted dark mid-lateral stripe, yellow scales on the middle of the lower side, and yellowish to reddish dorsal and anal fins, the latter usually with a yellow basal stripe. This species also has the shortest average caudal-peduncle length (14.5 % SL versus 14.7-16.1 %) and highest average number of anal rays (23.4 vs. 21.3-22.8, Table II) compared to other members of the group. Non-type specimens (WAM P.34395-001) from Sungai Pama collected by H. Bleher in 2013 have a notably different colour pattern (Appendix Fig. 1) and appear to mature at a much smaller size than other Etna Bay populations. However, on the basis of our genetic analysis, they are essentially identical to the population from the Amabalanga type locality. In addition, a *Melanotaenia* species (Appendix Fig. 2) that appears nearly identical to *M. etnaensis* was obtained by H. Bleher, also in 2013, from a location (approximately 4.0° S, 134.5°E, indicated with a question mark in Fig. 1) only about 9.2 km west of the type locality of *M. etnaensis*, but from a stream flowing into the open sea, outside of Etna Bay. Clearly, additional specimens are required to better elucidate the status of this fish as well as the one from Sungai Pama.

Distribution and habitat: The new species is apparently confined to streams mainly flowing into Etna Bay, West Papua (Fig. 1) or in its immediate vicinity. The bay is situated on the southern coast of New Guinea, approximately 100 km southeast of the town of Kaimana. This large bay extends for approximately 55 km inland, progressively narrowing from the 15 km-wide mouth to the inner sections, which average only 1-2 km in width. The bay is spectacularly scenic with rainforest-covered mountains rising to over 1,000 m around much of

the periphery with the exception of the southwestern section, which is low-lying swampland. Numerous creeks and small rivers flow into the bay throughout its length. We have collected or observed *M. etnaensis* from Sungai Ambalanga (type locality, Fig. 11), a small river situated at the mouth of the bay, and also from several small creeks flowing into the extreme inner portion. The habitat generally consists of rainforest (both primary and second growth) streams and the fish is generally found in deeper pools littered with fallen logs and branches. Temperature and pH recorded by Heiko Bleher during February 2013 at the type locality and Sungai Pama ranged from 25.3-27.8°C and 7.4-8.8, respectively.

Etymology: The new species is named *etnaensis* with reference to the Etna Bay type locality.

Melanotaenia grunwaldi, n. sp.

Grunwald's Rainbowfish
(Figs 12-13; Tables II & V)

Holotype: MZB 22777, male, 75.3 mm SL, Topo River, 03°26.914'S, 135°32.974'E, Papua Province, Indonesia, seine net, J. Graf & G. Lange, 12 August 2012.

Paratypes: MZB 22778, 4 specimens, 49.2-59.2 mm SL, Sungai Pepaya, 03°26.925'S, 135°32.955'E, tributary of Topo River, Papua Province, Indonesia, seine net, J. Christian, H.-G. Evers & A. Wagnitz, 13 January 2015; WAM P.34396-001, 2 specimens, 60.1-72.4 mm SL, collected with holotype; WAM P. 34397-001, 4 specimens, 47.9-59.7 mm SL, Sungai Lebki, 03°29.425'S, 135°35.596'E, Wami River system, about 16 km southeast of Nabire town, West Papua Province, Indonesia, seine net, J. Christian, H.-G. Evers & A. Wagnitz, 13 January 2015.

Non-type specimens: MZB 22952, 5 specimens, 53.0-74.8 mm SL, collected with WAM P.34397-001.

Diagnosis: A species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays V or VI-I,12 or 13 (usually 12 vs. usually 13 or more in other Birds Neck members of the "Goldiei" group); anal rays I,20-23; pectoral rays 13-15 (usually 14 or 15); lateral scales 33-36 (usually 34), predorsal scales 16 or 17; cheek scales 16-22, including 1-3 scales on preorbital; total gill rakers on first arch 15-17 (usually 15 or 16); largest average eye diameter, (9.2 % SL vs. 8.0-8.9 %) and longest average predorsal distance (50.7 % SL vs. 47.0-49.7 %) for Birds Neck members of the "Goldiei" group; colour of adult male in life generally brownish dorsally grading to whitish ventrally with prominent blue mid-lateral stripe from eye to caudal-fin base and longitudinal yellow zone immediately above midlateral stripe; outer portion of second dorsal fin, basal portion of anal fin, and basal half of caudal fin and adjacent peduncle (except where intersected by dark midlateral stripe) yellow.

Description: Dorsal rays VI-I,12 (V or VI-I,12, except two paratypes with 13); anal rays I,21 (I,20-23); pectoral rays 15 (13 to 15); pelvic rays I,5; branched caudal rays 15; procurrent caudal rays 6 + 5 (5-7 + 5-8); lateral scales 34 (33-36); transverse scales 10; predorsal scales 16 (16-17); prepelvic scales 17 (14-17); cheek scales 20 (16-22), including 2 (1-3) scales on preorbital; circumpeduncular scales 14 (two paratypes with 13); total gill rakers on first arch 16 (15-17).

Body depth 2.7 (2.7-3.5) in SL; HL 3.8 (3.5-3.7) in SL; greatest width of body 2.5 (2.1-2.5) in greatest body depth; snout length 3.5 (2.7-3.4) in HL; eye diameter 3.1 (2.7-3.2) in HL; interorbital width 2.5 (2.5-2.8) in HL; depth of caudal peduncle 2.3 (2.3-2.6) in HL; length of caudal peduncle 1.6 (1.7-1.9) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends almost below anterior edge of eye; maxillary length 2.9 (2.8-3.2) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 8-10 irregular rows anteriorly, reduced to single row posteriorly where exposed when mouth closed; teeth in lower jaw in about 8-10 irregular rows anteriorly, reduced to 1 or 2 rows posteriorly; vomerine teeth poorly developed, usually a few small teeth in narrow row; palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; row of small, truncated scales along bases of dorsal and anal fins; no scales on membranous portions of fins except several rows of small scales basally on caudal fin and triangular scale patch medially between base of pelvic fins; scale margins weakly crenulate; predorsal scales extending forward to about middle of interorbital space; preopercle with 2-3 scale rows between its posterior angle and eye.

Predorsal length 2.0 (1.8-2.1) in SL; preanal

length 1.9 (1.9-2.0) in SL; prepelvic length 2.6 (2.5-2.7) in SL; length of second-dorsal fin base 4.1 (3.8-5.0); length of anal-fin base 2.5 (2.5-2.9).

First dorsal fin origin about level with anal fin origin; longest spines (usually third or fourth) of first dorsal fin 2.0 (1.8-2.4) in HL, its depressed tip reaching spine or first soft ray of second dorsal fin or slightly beyond; longest rays (generally anterior ones in females and middle to posterior ones in males) of second dorsal fin 1.5 (1.8-2.5) in HL, adpressed posterior rays extending about one half length of caudal peduncle in females and full length of caudal peduncle in mature males; longest (anterior) anal rays 2.0 (2.0-2.5) in HL; pelvic fin tips when adpressed reaching to base of first or second soft anal fin ray in mature adults; length of pelvic fins 1.7 (1.5-1.8); length of pectoral fins 1.4 (1.4-1.7) in HL; length of caudal fin 1.2 (1.0-1.3) in HL; caudal fin moderately forked, caudal concavity 3.9 (3.1-5.9) in HL.

Colour in life (Fig. 12): yellow-brown dorsally on head and greenish brown on upper back, grading to whitish ventrally; blue midlateral stripe from eye to caudal-fin base, widest portion on caudal peduncle where it covers about two horizontal scale rows; narrow brass-coloured stripe between each scale row on upper two-thirds of side; longitudinal yellowish zone on side immediately above blue mid-lateral stripe, extending onto upper caudal peduncle, also yellow ventrally on caudal peduncle below blue midlateral stripe; diffuse bluish zone anteriorly on lower side beginning at level of

Fig. 12. Aquarium photographs of *Melanotaenia grunwaldi*, adult male (upper), approximately 65 mm SL, Siriwo River, photo by G. Lange and female, approximately 60 mm SL, Sungai Lebki, West Papua Province, Indonesia. Photo by R. Hadiaty.

lower pectoral-fin base, extending posteriorly to level of about tenth soft anal ray; yellowish stripe (with metallic reflections) behind eye extending across upper cheek and middle of operculum where punctuated posteriorly with small red spot; dorsal, anal, pelvic and caudal fins yellow, except broadly translucent whitish on base of second dorsal and distal margin of anal and caudal fins; pectoral fins translucent yellowish. Colour pattern of female (Fig. 12, lower) similar to that of male except lacking yellow areas on body and fins.

Colour in alcohol (Fig. 13): brown dorsally grading to yellowish white on lower half of head and body; blackish stripe from behind eye to base of caudal fin, anterior part about one scale wide, posterior portion slightly more than two scales wide; scales on ventral part of body above anal fin with broad blackish margins, occupying two horizontal scale rows; fins dusky tannish to translucent whitish. Paratypes similar to holotype, but smaller individuals (> about 60 mm SL) generally lacking dark-edged scales above anal fin and with distinct tannish stripe above posterior half of blackish midlateral stripe.

Comparisons: Adult males are distinguished by their bronze colouration on the upper half of the body, yellow scale margins, and narrow dark margins on the upper and lower edge of the caudal fin. This species has the largest average eye diameter 9.2 % SL vs. 8.0-8.9 %) and longest average predorsal distance (50.7 % SL vs. 47.0-49.7 %) for the Birds Neck members of the "Goldiei" group. It is also the only member of this group that usually has 12 soft dorsal rays (vs. counts of 13-15, Table II).

Distribution and habitat: The new species is currently known only from three sites (Fig. 1) in the upper Wami River system, which rises in hills within about 15-20 km southeast of the coastal town of Nabire, in Papua Province, Indonesia. These sites are located along the Nabire-Enaratoli road, one at the Topo River, another in a nearby tributary, and the third at the Lebki River. The first two locations are about 10 km south of Nabire and lie at an elevation of about 193 m above sea level (Fig. 14). The third is about 6 km farther inland at an elevation 116 m. Specimens were captured in moderately fast-flowing conditions over a rock and gravel

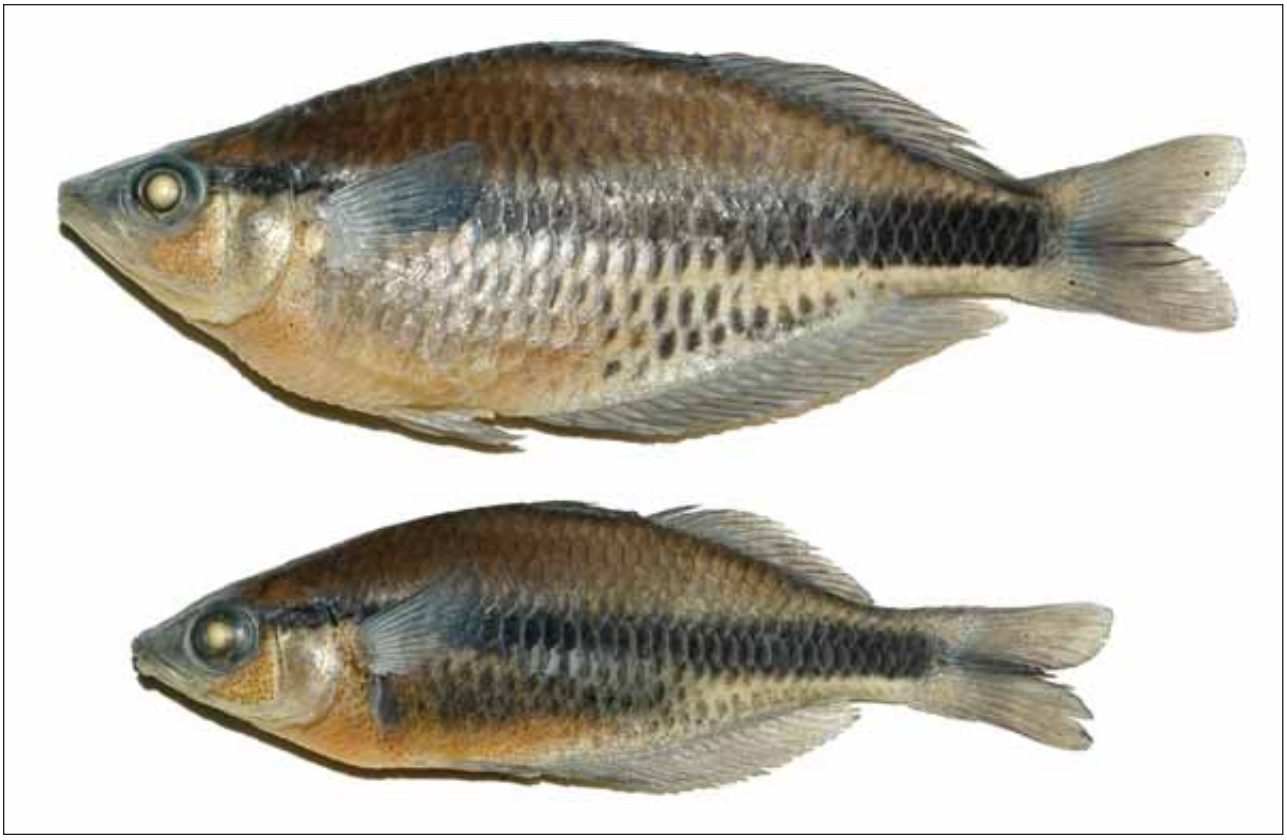

Fig. 13. Preserved type specimens of *Melanotaenia grunwaldi:* male holotype (upper), 75.3 mm SL and female paratype (lower), 60.1 mm SL, Topo River, Papua Province, Indonesia. Photo by G. R. Allen.

Table V. Proportional measurements of selected type specimens of *Melanotaenia grunwaldi* expressed as percentage of the standard length.

	Holotype MZB 22777	Paratype WAM P.34396	Paratype MZB 22778	Paratype MZB 22778	Paratype MZB 22778	Paratype WAM P.34396	Paratype MZB 22778	Paratype WAM P.34397
Sex	male	male	male	male	male	female	female	female
Standard length (mm)	75.3	72.4	59.2	54.0	49.2	60.1	52.8	48.9
Body depth	36.9	36.9	32.4	30.6	31.5	33.7	30.7	29.1
Body width	14.8	14.9	14.4	13.8	14.2	14.8	14.8	13.7
Head length	26.3	28.1	27.8	28.3	28.6	27.5	28.6	28.1
Snout length	7.5	9.3	9.4	8.9	8.4	9.5	9.8	9.7
Eye diameter	8.4	8.7	9.0	9.8	9.4	9.0	9.3	9.4
Maxillary length	9.0	10.1	9.3	9.3	8.9	9.4	9.7	9.2
Bony interorbital width	10.4	10.7	10.6	11.3	11.3	10.9	11.0	9.9
Depth of caudal peduncle	11.5	11.8	11.1	11.4	12.0	11.6	12.5	10.6
Length of caudal peduncle	16.5	16.4	16.8	15.6	15.5	15.9	15.6	14.7
Predorsal distance	50.4	54.2	50.4	50.8	51.7	53.3	50.1	49.8
Preanal distance	51.4	53.7	52.5	51.3	50.4	51.0	52.8	51.8
Prepelvic distance	37.9	40.3	40.4	39.5	36.6	38.4	39.0	38.2
2nd dorsal-fin base	24.5	26.0	20.5	21.1	21.3	22.8	20.1	20.5
Anal-fin base	39.7	40.1	37.0	37.5	35.5	36.5	35.4	35.0
Pectoral-fin length	18.8	18.9	18.8	19.3	19.0	20.5	19.2	18.4
Pelvic-fin length	15.4	17.5	16.5	18.5	17.3	16.1	16.9	16.1
Longest ray 1st dorsal fin	13.2	12.6	15.2	14.4	13.7	11.6	13.3	13.3
Longest ray 2nd dorsal fin	18.1	15.8	12.6	13.9	12.9	11.2	12.9	12.7
Longest anal ray	13.4	14.4	12.3	13.7	13.1	11.2	11.3	11.9
Caudal-fin length	22.3	27.6	21.7	24.6	25.0	24.9	24.5	26.2
Caudal concavity	6.8	9.0	5.7	6.2	4.8	6.1	8.5	6.4

Fig. 14. Type locality of *Melanotaenia grunwaldi* at Topo River, Papua Province, Indonesia. Photo by G. Lange.

bottom. Temperature and pH values of 25.0-26.3°C and 7.5-8.2 respectively were recorded. The very first specimens of this new species were collected in the Wami River system by G. R. Allen & H. Bleher 1982.

Etymology: The new species is named *grunwaldi* in honour of the late Norbert Grunwald, a well-known and highly respected German aquarist who devoted much of his life to captive rainbowfishes and contributed considerable knowledge on their maintenance and biology.

Melanotaenia lacunosa, n. sp.

Mbuta Rainbowfish
(Figs 15-16; Tables II, VI)

Holotype: MZB 20891, male, 88.1 mm SL, Lake Mbuta Basin, 03°53.077'S, 134°32.403'E, about 12 km northwest of Etna Bay, West Papua, Indonesia, to 1.5 m depth, rotenone, G. R. Allen, T. Tabuni & M. Warus, 28 April 1997.

Paratypes: MZB 20892, 3 specimens, 73.7-74.5 mm SL, collected with holotype; MZB 21755, 8 specimens, 23.2-33.9 mm SL, stream draining into Danau Mbuta at logging camp on Kayu Merah-Mbuta road, 03° 51.767'S, 134° 31.436'E, seine net, M. Erdmann & Abraham Sianipar, 8 December 2013; MZB 21759, 2 specimens, 23.7-33.8 mm SL, small river, 03° 53.577'S 134° 28.233'E, about 8 km from Kayu Merah village on road to Mbuta Basin, seine net, M. Erdmann & Abraham Sianipar, 8 December 2013; WAM P.31300-002, 5 specimens, 48.2-81.1 mm SL, collected with holotype; USNM 406857, 4 specimens 50.6-67.2 m SL, collected with holotype; RMNH 37990, 4 specimens, 48.6-65.4 mm SL, collected with holotype.

Diagnosis: A species of melanotaeniid distinguished by the following combination of characters: dorsal rays V or VI-I,13-15; anal rays I,21-24 (usually 22-24); pectoral rays 14-16 (usually 15); lateral scales 35-36 (usually 36), predorsal scales 16-17; cheek scales 17-19 ($\overline{x}$ = 17.5); total gill rakers on first arch 12 to 15 (usually 14, compared to 15-16 in other Birds Neck members of the "Goldiei" group); head length 3.3-3.7 ($\overline{x}$ = 3.48) in SL; depth of caudal peduncle 2.5-3.1 ($\overline{x}$ = 2.73) in HL; average body depth of males 55-69 mm SL = 31.9 % SL, of males 70-84 mm SL = 34.9 % SL, of males 85+ mm SL = 34.9 % SL; colour in life generally bronze-yellow dorsally grading to bluish white on belly and yellowish on posterior half of ventral body with blue markings on scales; dark blue mid-lateral stripe from eye to caudal-fin base, most conspicuous on posterior half of body; diffuse red or orange spot posteriorly on operculum.

Description: Dorsal rays VI-I,14 (V or VI-I,13 to 15); anal rays I,24 (I,21-24); pectoral rays 15 (14-16); pelvic rays I,5; branched caudal rays 15; procurrent caudal rays 4-7; lateral scales 35 (35-36); transverse scales 11 (10-11); predorsal scales 15 (16-17); prepelvic scales 16 (16-17); cheek scales 19 (17-19, $\overline{x}$ = 17.5); circumpeduncular scales 14; total gill rakers on first arch 14 (12-15).

Body depth 2.8 (2.7-3.5) in SL; head length 3.6 (3.3-3.7) in SL; greatest width of body 2.6 (2.0-2.6) in greatest body depth; snout length 2.7 (2.6-3.2) in HL; eye diameter 3.6 (2.9-3.6) in HL; interorbital width 2.6 (2.4-2.7) in HL; depth of caudal peduncle 2.6 (2.5-3.1, $\overline{x}$ = 2.73) in HL; length of caudal peduncle 1.8 (1.7-2.1) in HL.

Jaws nearly equal, lower jaw slightly inferior; mouth oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends below about anterior edge of eye; maxillary length 2.8 (2.6-3.1) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in about six irregular rows anteriorly, reduced to a single row posteriorly, where they are exposed when mouth is closed; teeth in lower jaw in about 8-9 irregular rows anteriorly, reduced to 1 or 2 rows posteriorly; narrow row containing several small, conical teeth on vomer and palatines, those on palatines relatively scarce and usually embedded in thick mucous layer.

Scales of body cycloid with scalloped posterior margin, relatively large, and arranged in regular horizontal rows; row of small, truncated scales along bases of dorsal and anal fins; no scales on membranous portions of fins except several rows of small scales basally on caudal fin and triangular scale patch medially between base of pelvic fins; predorsal scales extending forward to posterior half of interorbital space; preopercle with 2-3 scale rows between its posterior angle and eye.

Predorsal length 2.1 (2.0-2.1) in SL; preanal length 2.0 (1.8-2.0) in SL; prepelvic length 2.6 (2.4-2.7) in SL; length of second-dorsal fin base 3.8 (3.6-4.2) in SL; length of anal-fin base 2.4 (2.3-2.8) in SL.

First dorsal fin origin about level with anal fin origin; longest spine (usually third or fourth) of first dorsal fin 1.5 (1.4-2.3) in HL, its depressed tip reaching base of spine or first soft ray of second

dorsal fin in females and reaching to about base of second or third soft ray in mature males; longest rays (generally anterior ones in females and middle to posterior ones in males) of second dorsal fin 1.8 (1.7-2.2) in HL, depressed posterior rays extending about one half of caudal peduncle in females and full length of caudal peduncle in mature males; longest (middle rays in males and anterior rays in females) anal rays 1.7 (1.7-2.3) in HL; pelvic fin tips when depressed reaching to base of second or third soft anal fin ray in mature males and reaching base of anal spine or first soft ray in females; length of pelvic fins 1.6 (1.4-2.0) in HL; length of pectoral fins 1.5 (1.3-1.5) in HL; length of caudal fin 1.2 (1.2-1.4) in HL; caudal fin moderately forked, caudal concavity 4.1 (3.1-6.2) in HL.

Colour when fresh (Fig. 15 upper): male bronze-yellow to bluish grey on upper back, grading to bluish white (anteriorly) or yellowish (posteriorly) on lower half of side; bluish grey mid-lateral stripe from pectoral region to caudal-fin base, widest portion on caudal peduncle where it covers about two horizontal scale rows; pale yellow stripe immediately below, about one-third width of dark mid-lateral stripe; most of scales above anal fin base with variable amount of bluish grey colouration; head blue greyish with silvery stripe behind eye extending across upper operculum where punctuated with diffuse red or orange spot; dorsal, anal, pelvic and caudal fins pale yellowish to reddish-white; caudal fin translucent bluish; pelvic fins whitish; pectoral fins translucent.

Colour in alcohol (Fig. 16): dark grey dorsally on head and adjacent pre-dorsal region; mainly yellowish tan on side of body, grading to silvery whitish ventrally; blackish mid-lateral stripe from behind eye to base of caudal fin, most conspicuous on posterior half of body, widest on caudal pedun-

Fig. 15. Freshly collected male paratype (MZB 20892) of *Melanotaenia lacunosa*, 74.5 mm SL (upper) and aquarium photograph of young female, approximately 35 mm SL, tributary flowing into Lake Mbuta, West Papua Province, Indonesia. Photo by G. R. Allen.

Table VI. Proportional measurements of selected type specimens of *Melanotaenia lacunosa* expressed as percentage of the standard length.

	Holotype MZB 20891	Paratype WAM P.31300	Paratype MZB 20892	Paratype RMNH 37990	Paratype USNM 406857	Paratype RMNH 37990	Paratype USNM 406857	Paratype RMNH 37990
Sex	male	male	male	male	female	female	female	female
Standard length (mm)	88.1	81.1	74.5	53.2	67.2	65.3	54.2	49.1
Body depth	35.3	37.2	34.2	30.3	29.6	29.2	28.4	29.3
Body width	14.4	14.8	14.9	13.1	13.8	13.0	13.7	11.2
Head length	28.1	27.9	28.1	28.6	28.4	29.4	29.2	29.9
Snout length	10.4	9.5	10.5	9.3	10.0	9.5	9.2	10.6
Eye diameter	7.8	7.8	8.5	9.5	9.2	8.7	9.8	10.2
Maxillary length	10.0	9.0	9.9	10.3	10.1	9.3	9.6	10.8
Bony interorbital width	10.9	11.3	11.7	10.8	11.3	11.5	11.1	11.2
Depth of caudal peduncle	11.0	11.2	10.9	11.2	9.4	10.0	10.7	9.8
Length of caudal peduncle	15.9	14.8	15.2	15.9	16.2	16.8	14.9	17.1
Predorsal distance	48.7	47.8	47.5	47.3	49.6	47.9	48.7	50.5
Preanal distance	49.9	50.1	50.9	53.4	52.4	52.5	53.3	55.0
Prepelvic distance	37.9	37.6	38.8	37.9	39.0	40.3	40.8	40.9
2nd dorsal-fin base	26.4	28.0	28.1	24.1	24.7	26.0	25.6	24.2
Anal-fin base	41.4	44.0	39.5	35.9	36.5	35.2	36.5	35.6
Pectoral-fin length	19.1	21.1	19.7	18.9	18.6	19.6	20.1	19.3
Pelvic-fin length	18.2	19.4	14.9	16.5	16.7	16.1	16.8	15.1
Longest ray 1st dorsal fin	18.3	17.3	18.5	11.7	15.0	15.3	13.3	14.1
Longest ray 2nd dorsal fin	15.3	14.9	16.6	14.2	13.7	13.9	13.7	13.4
Longest anal ray	16.2	15.4	13.3	11.3	12.6	13.2	12.5	13.4
Caudal-fin length	22.8	23.1	21.3	22.8	22.8	23.3	22.9	24.0
Caudal concavity	6.8	8.9	6.8	6.3	7.1	7.0	7.4	7.5

cle, covering about two horizontal scale rows; whitish stripe immediately below, about one-third width of dark mid-lateral stripe; wedge-shaped area above anal fin with dusky grey base on each scale; fins mainly translucent whitish or tan, males with narrow dark margins on dorsal and anal fins. Male paratypes are generally similar to the holotype, but there is considerable variation in the intensity of the mid-lateral dark stripe. Female paratypes are generally pale tan with a faint greyish mid-lateral stripe.

Fig. 16. Preserved holotype of *Melanotaenia lacunosa*, male, 88.1 mm SL, Mbuta Basin, Etna Bay, West Papua Province, Indonesia. Photo by G. R. Allen.

Comparisons: A photograph of the freshly preserved male paratype (Fig. 15, upper) indicates this species has a distinctive, broad yellowish area immediately above the dark mid-lateral stripe and narrower pale yellow stripe immediately below it, as well as yellow-margined scales on the middle of the lower side. Compared with other members of the Birds Neck "Goldiei" group this species has the longest average snout length (9.9 % SL vs. 8.8-9.6 %), the longest preanal distance (51.9 % SL, vs. 49.4-51.7 %), and longest prepelvic distance (38.9 % SL vs. 36.9-38.7 %). It also has the highest percentage (76.5 %) of individuals with 15-16 pectoral rays. Most of the other species have lower counts with the percentage of those with 15 or more rays ranging from 12.5-46.2 % of individuals, except for *M. dumasi*, which has 66.6 % (Table II).

Distribution and habitat: This species is known only from streams in the vicinity of Mbuta (sometimes spelled Mbutu) Basin near Etna Bay, West Papua Province (Fig. 1). The holotype and most of the paratypes were obtained in the main portion of the Basin by the first author in 1997 via helicopter access from a temporary exploration camp maintained by Freeport Indonesia Mining Company. Additional paratypes were collected in 2013 from nearby streams on a recently constructed road linking the Mbuta Basin with Kayu Merah Bay. Mbuta Basin consists of an oval-shaped basin, approximately 9 km long and 3.2 km wide, along a NE-SE axis. Its southeastern end is only 3.5 km from Etna Bay via a narrow valley flanked by 800-900 m high ridges. The valley gradually ascends from the bay to a 200 m high pass before opening into Mbuta Basin, which lies at an elevation of 170 m above sea level. The basin is often represented on published maps and charts as a lake, but in 1997 it was marshland surrounded by low mountains. Much of the basin floor was covered with 3-4 m tall grass with numerous small ponds (Fig. 17), creeks, and at least one small river. Drainage is apparently subterranean, which is typical of other lakes in this limestone region. There is no apparent outflow to nearby Etna Bay. The basin is uninhabited by humans, but supports large numbers of wild pig and deer. Contrary to conditions in 1997, the basin was inundated in December 2013 (Mark Erdmann, personal communication) with widespread lacustrine conditions, therefore indicative of widely fluctuating conditions, depending on local rainfall.

The type specimens collected in 1997 were captured with rotenone in a 2-3 m-wide creek with

Fig. 17. Aerial photograph of Mbuta Basin taken near the type locality of *Melanotaenia lacunosa* in April 1997. Photo by G. R. Allen.

depths to about 2 m. The collection was made over a 50 m-long section immediately above its confluence with a small turbid river (Fig. 18). The water was very clear, but darkly stained (tea-coloured), with relatively fast flow through forest that almost formed a closed canopy. The bottom consisted mainly of mud with occasional rocks and log debris with sparse aquatic vegetation. A water temperature of 25.8°C and pH of 6.4 were recorded. Other inhabitants of the creek included another endemic genus and species of rainbowfish *(Pelangia mbutaensis)*, a plotosid catfish *(Neosilurus brevidorsalis)*, an atherinid *(Craterocephalus* sp.), a gobiid *(Glossogobius* sp.), two eleotrids *(Mogurnda mbuta* and *Oxyeleotris fimbriata)*, and a parastacid crayfish *(Cherax* sp.). The new species was the most abundant fish collected at this site. An attempt to reach this location in 2013 was thwarted due to high water levels when the site of the former stream was flooded by a large lake.

Fig. 18. Type locality of *Melanotaenia lacunosa* at Mbuta Basin, West Papua Province, Indonesia. Photo by G. R. Allen.

Etymology: The new species is named *lacunosa* (Latin: "full of lakes and ponds") with reference to the many small ponds and larger lakes found in the Mbuta Basin.

Melanotaenia mamahensis, n. sp.

Mamah Rainbowfish
(Figs 19-20; Tables II & VII)

Holotype: MZB 22779, male, 61.7 mm SL, Sungai Mamah, 03°20.489'S, 134°59.971'E, West Papua Province, Indonesia, seine net, J. Christian, H.-G. Evers & A. Wagnitz, 14 January 2015.
Paratypes (collected with holotype): MZB 22780, 54.1 mm SL; MZB 22950, 5 specimens, 53.4-75.8 mm SL; WAM 34398-001, 2 specimens, 53.3-54.6 mm SL.

Diagnosis: A species of melanotaeniid rainbowfish distinguished by the following combination of characters: dorsal rays V or VI-I,12-15; anal rays I,21-22; pectoral rays 13-15; lateral scales 32-34, predorsal scales 15-18; cheek scales 16-18, including 2-3 scales on preorbital; total gill rakers on first arch 14-16; shortest average snout length (8.7 % SL vs. 9.0-9.9 %), predorsal distance (47.7 % SL versus 47.9-49.7 %), and number of prepelvic scales (14.6 vs. 15.8-17.8) compared with other members of the Birds Neck "Goldiei" group; colour of adult male in life brown to bluish grey dorsally on head and body, whitish to pale bluish grey on ventral portions and blue midlateral stripe from eye to caudal-fin base, relatively broad yellow zone immediately above and parallel to dark midlateral blue stripe; first dorsal fin reddish anteriorly, grading to bluish posteriorly; second dorsal fin reddish to yellowish; anal fin red basally and mainly translucent bluish on outer half; caudal fin dusky greyish; pelvic fins white.

Description: Dorsal rays V-I,14 (V or VI-I,12-15); anal rays I,22 (I,21-22); pectoral rays 15 (13-14); pelvic rays I,5; branched caudal rays 15; procurrent caudal rays 5 + 5 (4-5 + 5-6); lateral scales 34 (32-34); transverse scales 10; predorsal scales 16 (15-18); prepelvic scales 14 (14-16); cheek scales 17 (16-18), including 3 (2-3) scales on preorbital; circumpeduncular scales 14; total gill rakers on first arch 16 (14-16).

Body depth 3.0 (2.8-3.6) in SL; HL 3.8 (3.6-3.9) in SL; greatest width of body 2.2 (1.9-3.2) in greatest body depth; snout length 2.9 (2.9-3.2) in HL; eye diameter 3.5 (3.0-3.3) in HL; interorbital

width 2.7 (2.3-2.7) in HL; depth of caudal peduncle 2.3 (2.1-2.4) in HL; length of caudal peduncle 1.8 (1.4-1.8) in HL.

Jaws about equal, oblique, premaxilla with an abrupt bend between the anterior horizontal portion and lateral part; maxilla ends almost below anterior edge of eye; maxillary length 3.0 (2.7-3.2) in HL; lips thin; teeth conical with slightly curved tips, extending on to outer surface of lips; teeth of upper jaw in 4-5 irregular rows anteriorly, reduced to single row posteriorly where exposed when mouth closed; teeth in lower jaw in about 8-9 irregular rows anteriorly, reduced to 1 or 2 rows posteriorly; vomerine teeth poorly developed, usually a few small teeth in narrow row; palatine teeth absent.

Scales of body cycloid, relatively large, and arranged in regular horizontal rows; row of small, truncated scales along bases of dorsal and anal fins; no scales on membranous portions of fins except several rows of small scales basally on caudal fin and triangular scale patch medially between base of pelvic fins; scale margins weakly crenulate; predorsal scales extending forward to about middle of interorbital space; preopercle with 3 scale rows between its posterior angle and eye.

Predorsal length 2.1 (2.0-2.2) in SL; preanal length 2.0 (1.9-2.1) in SL; prepelvic length 2.6 (2.6-2.8) in SL; length of second-dorsal fin base 3.8 (3.4-4.2); length of anal-fin base 2.4 (2.3-2.7).

First dorsal fin origin about level with anal fin origin; longest spines (usually third) of first dorsal fin 1.8 (1.6-2.1) in HL, its adpressed tip reaching to base of second or third soft ray of second dorsal fin of male and to base of second dorsal fin origin of female; longest rays (posterior rays in male and anterior rays in female) of second dorsal fin 1.9 (1.5-1.9 in males, 1.8-2.2 in females) in HL, adpressed posterior rays extending entire length of caudal peduncle in male holotype and about half length of caudal peduncle in female paratype; longest (middle) anal rays 1.9 (1.9-2.2) in HL; pelvic fin tips when adpressed reaching to base of second soft anal fin ray in male holotype and to base of anal spine of female paratype; length of pelvic fins 1.6 (1.4-1.7); length of pectoral fins 1.4 (1.3-1.4) in HL; length of caudal fin 1.2 (1.1-1.2) in HL; caudal fin moderately forked, caudal concavity 5.5 (2.6-5.6) in HL.

Colour in life (Fig. 19): adult male brown dorsally on head and predorsal midline, bluish grey on side of nape and most of upper back; blue midlateral stripe from eye to caudal-fin base, usually darkest and widest on caudal peduncle where it covers 1.5-2 horizontal scale rows; narrow orange stripe between each scale row on upper half of side; relatively broad yellow zone immediately above and parallel to dark midlateral blue stripe, occupying 1-2 scale rows; lower side pale bluish to light grey with whitish spot on centre of each scale; opercle and lower half of head whitish or pale greyish, usually with silvery reflections and red spot (about one-half pupil size) on upper rear corner of opercle; first dorsal fin reddish anteriorly, grading to bluish posteriorly; second dorsal fin reddish to yellowish; anal fin red basally and mainly translucent bluish on outer half; caudal fin dusky greyish; pelvic fins white; pectoral fins mainly translucent. Female (Fig. 19, lower) colouration similar to that of male.

Colour in alcohol (Fig. 20): brown on back and dorsally on head, lower side of body whitish with dusky-grey scale margins; blackish midlateral stripe from upper rear corner of eye to caudal-fin base; also distinct narrow, tan stripe on posterior half of body immediately above dark midlateral stripe; fins mainly dusky greyish except pectorals and pelvics translucent whitish.

Comparisons: The adult male is distinguished by a broad yellow zone above the mid-lateral stripe and yellowish scale margins on the back, which exhibit variable intensity. This species also has the shortest average snout length (8.7 % SL vs. 9.0-9.9 %) and shortest average predorsal distance (47.7 % SL vs. 47.9-49.7 %) compared with other members of the Birds Neck "Goldiei" group. It also has the lowest average number of prepelvic scales (14.6 vs. 15.8-17.8, Table II).

Distribution and habitat: The new species is known only from the type locality (Fig. 21), Sungai Mamah, a small creek situated about 50 km west of Nabire, near the edge of Cenderawasih Bay. The habitat consists of a clear, slow-flowing rainforest stream. The new species was reported as abundant, swimming in large groups, especially in the deeper, shaded sections. Temperature and pH values of 26.3°C and 7.9 respectively were recorded at the time of collection (January 2015).

Etymology: The new species is named *mamahensis* with reference to the type locality.

Genetic results and discussion: A total of 29 new sequences were obtained and combined with previously published data from all species in the "Goldiei" group (Unmack et al. 2013; Allen et al. 2015) for the mtDNA cyt*b* gene (Table I). The final dataset consisted of 36 individuals after identi-

cal haplotypes from the new sequences were removed. Within species genetic diversity was low, with three species containing three haplotypes each, while three had no variation, although most sample sizes were less than 4 (Table I). Sequence analysis of the 36 individuals (Table I) yielded 962 invariant characters, 50 variable but parsimony uninformative characters, and 129 parsimony informative characters. ML analysis recovered one tree with a likelihood score of -3248.589025 (Fig. 2). The relationships recovered were broadly congruent with the larger sequence dataset in Unmack et al. (2013). The closely related pair of *M. lacustris* and *M. monticola* as well as *M. mubiensis* comprise the earliest branching lineages within "Goldiei" group. Interestingly, these taxa, plus "*M. goldiei*" VIII all occur in the Kikori River system, but each are from deeply divergent lineages within this group (Fig. 2). The next lineage to diverge is represented by the easternmost populations of *M. goldiei* (X and XI; the latter being close to the type locality, which is near Port Moresby, Papua New Guinea). Relationships between most remaining lineages are poorly resolved (lacking bootstrap support), but contain a scattering of "*M. goldiei*" populations separated by other species such as *M. herbertaxelrodi*, three species from the Triton Lakes, West Papua *(M. kamaka, M. lakamora, M. pierucciae), M. trifasciata*, taxa recently separated from "*M. goldiei*" from the Aru Islands (Allen et al. 2015), and the

Fig. 19. Aquarium photographs of *Melanotaenia mamahensis*, adult male (upper) and female, approximately 85 and 60 mm SL respectively, Sungai Mamah, West Papua Province, Indonesia. Photo by H.-G. Evers.

Table VII. Proportional measurements of type specimens of *Melanotaenia mamahensis* expressed as percentage of the standard length.

	Holotype MZB 22779	Paratype MZB 22950	Paratype MZB 22950	Paratype MZB 22780	Paratype WAM P.34398	Paratype MZB 22950	Paratype MZB 22950	Paratype WAM P.34398
Sex	male	male	male	male	male	female	female	female
Standard length (mm)	61.7	75.8	70.0	54.1	53.3	60.6	57.2	54.6
Body depth	33.5	33.5	36.1	28.1	31.2	32.0	31.5	29.6
Body width	15.0	11.9	11.1	14.4	13.0	11.7	10.7	14.3
Head length	26.4	26.1	26.4	25.6	26.8	26.7	26.4	26.0
Snout length	9.0	8.4	8.7	8.3	8.9	8.4	8.7	8.9
Eye diameter	7.5	8.2	8.4	8.3	8.1	8.7	8.7	8.3
Maxillary length	8.7	9.8	9.0	8.4	9.2	8.9	8.7	8.5
Bony interorbital width	9.8	9.6	9.9	10.2	10.5	10.2	10.3	11.3
Depth of caudal peduncle	11.5	11.6	12.6	11.2	11.9	11.2	11.4	11.1
Length of caudal peduncle	14.8	18.2	16.1	16.0	14.7	16.8	15.9	15.3
Predorsal distance	46.9	48.7	48.3	47.0	46.4	49.2	47.0	47.5
Preanal distance	49.0	51.8	50.9	48.2	49.4	50.2	51.6	51.6
Prepelvic distance	37.6	37.5	38.1	36.1	36.8	38.3	38.3	38.1
2nd dorsal-fin base	27.3	27.7	29.7	25.9	26.5	24.1	27.6	26.0
Anal-fin base	40.4	39.6	43.9	41.6	39.6	38.1	41.6	36.8
Pectoral-fin length	19.5	18.3	18.4	20.1	19.3	19.8	19.1	19.3
Pelvic-fin length	16.7	16.2	17.4	18.0	16.7	16.0	16.1	15.3
Longest ray 1st dorsal fin	14.4	14.8	15.6	16.2	15.8	15.0	15.7	12.1
Longest ray 2nd dorsal fin	17.1	13.9	15.3	16.9	13.9	12.4	14.7	13.3
Longest anal ray	14.0	11.7	12.7	13.7	12.9	12.9	12.9	12.6
Caudal-fin length	21.1	24.4	24.9	23.3	24.1	21.8	24.7	23.9
Caudal concavity	4.8	9.8	9.4	5.5	5.4	4.8	10.0	7.7

species described herein (Fig. 2). Many of the remaining species/lineages are grouped with moderate to high bootstrap support that closely follow geographic patterns. As presently defined the Australian species *M. trifasciata* contains multiple distinct lineages, plus "*M. goldiei*" VII and *M. oktediensis* both from the Fly River (which are most closely related to the geographically proximate Cape York *M. trifasciata* III), along with *M. sencknenbergianus* from Aru Islands, which is genetically and geographically close to Arnhemland *M. trifasciata* II (Fig. 2). Central southern Papua New Guinea "*M. goldiei*" from the Kikori (VIII) and Lakekamu (IX) basins group together, as do south-

Fig. 20. Preserved holotype of *Melanotaenia mamahensis*, male, 61.7 mm SL, Sungai Mamah, West Papua Province, Indonesia. Photo by G. R. Allen.

ern central Papua forms from Lake Yamur *(M. dumasi)* in the west to Pulau drainage *("M. goldiei"* VI) and recently described species from Aru Islands *(M. kolaensis, M. picta, M. wokamensis)*. Lastly, the westernmost species described herein form a closely related group, with the northern coastal species having higher levels of divergences from each other *(M. mamahensis, M. grunwaldi, M. bowmani)* and the closely related southern pair of *M. lacunos*a from the Mbuta drainage and *M. etnaensis* from Etna Bay drainages. One interesting anomaly in the genetic data was a grouping of a divergent single individual *M. dumasi* haplotype (H1 III, previously referred to as *M. goldiei* III in Unmack et al. 2013) with *M. mamahensis* (Fig. 2; with a p-distance of 0.4 %). Given the larger p-distance and the geographic proximity of these two species this result is most likely due to some older mixing and introgression between these species. Introgression, involving the hybridisation and subsequent backcrossing of individuals over longer time periods is a common phenomenon in rainbowfishes. Unmack et al. (2013) identified 13 rainbowfish populations from 10 species that experienced historical introgression with replacement of their original mtDNA type. The situation here of having two distinct mtDNA types in the same population is unusual in rainbowfishes based on our experience, but is not uncommon in other fish groups.

Rainbowfishes are atypical compared to most families of freshwater fishes in the Australia-New Guinea region in that the group exhibits an extremely diverse range of colour patterns, which are frequently diagnostic between closely related species (Allen 1995). The evidence strongly suggests that these colour traits evolved rapidly once populations were isolated. Traditionally, these colouration differences were usually associated with small morphological and/or meristic differences (often modal rather than non-overlapping values), resulting in numerous new species descriptions. The subsequent development of molecular datasets in rainbowfishes (Unmack et al. 2013) provided an excellent test of how well traditional taxonomy was supported by modern genetic methods. Virtually all described species were clearly distinguished by molecular data, suggesting that past approaches for describing rainbowfishes were highly consistent with molecular data, although two major exceptions were noted. The first consisted of three species groups, which could not be separated by molecular data: three *Glossolepis* species *(G. dorityi, G. incisus* and *G. pseudoincisus)*, three species from Triton Lakes (Fig. 2, Table VIII, *M. kamaka, M. lakamora* and *M. pierucciae)* and two species from the upper Kikori River system (Fig. 2, Table VIII, *M. lacustris* and *M. monticola)*. In all three examples the species are in close geographic proximity and neither mtDNA nor nuclear DNA could distinguish any of the species (Unmack et al., 2013). However, clear morphological and/or meristic differences were present along with substantial colour differences in most cases. That molecular data could not distinguish these species simply implies recent differentiation such that genetic differences in the markers sequenced had not accumulated differences, or that introgression has occurred in the markers examined. The second major exception involved lineages where molecular data (Unmack et al. 2013) suggested that morphological and meristic data (Allen & Cross 1982) may have underestimated the actual number of species, particularly with regards to geographically widespread taxa such as *Chilatherina fasciata, Melanotaenia goldiei* and *M. trifasciata,* of which none were recovered as monophyletic groups with genetic data.

Fig. 21. Type locality of *Melanotaenia mamahensis* at Sungai Mamah, West Papua Province, Indonesia. Photo by H.-G. Evers.

The occurrence of "cryptic" species lacking clear morphological differences is certainly a common feature in this large and diverse family. Our previous study (Allen et al. 2015) of the rainbowfishes of the Aru Islands revealed that the *goldiei* lineage from that area includes at least four species. The present study of the Birds Neck region represents our continuing effort to elucidate additional taxa in this lineage as revealed by molecular results. The challenge with the species dealt with herein is that while they all have strong genetic differences (min-

Table VIII. Mean p-distances expressed as a percentage between rainbowfish species for cytochrome *b*. Species are presented in the same order as Figure 2.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
M. lacunosa	1																													
M. etnaensis	2	0.5																												
M. bowman	3	0.7	0.9																											
M. grunwaldi	4	1.5	1.6	1.5																										
M. mamahensis	5	2.2	2.3	2.2	2.2																									
M. goldiei_IV	6	2.5	2.6	2.6	2.7	2.2																								
M. goldiei_I	7	2.3	2.3	2.4	2.5	1.9	0.6																							
M. picta	8	2.6	2.6	2.8	2.9	2.5	1.2	1																						
M. wokamensis	9	2.6	2.7	2.9	3	2.6	1.3	0.9	0.6																					
M. kolaensis	10	2.5	2.5	2.5	2.6	2.3	1.1	0.9	0.4	0.5																				
M. goldiei_VI	11	2.5	2.5	2.5	2.6	2.1	0.8	0.7	1.1	1.2	0.9																			
M. goldiei_V	12	2.8	2.8	2.8	3.1	2.5	1.2	1.1	1.6	1.7	1.3	0.8																		
M. dumasi	13	2.6	2.7	2.6	2.7	1.7	1.5	1.4	1.8	1.9	1.5	1.2	1.6																	
M. goldiei_VIII	14	3.2	3.3	3.2	2.9	2.7	2.6	2.5	3.2	3.2	2.9	2.5	3	2.9																
M. goldiei_IX	15	2.9	3.1	3	2.5	2.7	2.6	2.5	3.2	3.2	2.9	2.5	3.2	2.9	0.9															
M. herbertaxelrodi	16	2.5	2.6	2.5	2.4	2.2	2.3	2	2.5	2.5	2.4	2	2.6	2.5	2.6	2.6														
M. pierucciae	17	2.8	3	3	2.7	2.5	2.6	2.4	2.8	2.7	2.7	2.5	3	2.8	3	2.8	2.3													
M. lakamora	18	2.9	3.1	3.1	2.8	2.6	2.7	2.5	2.9	2.8	2.8	2.6	3.1	2.9	3.1	2.9	2.4	0.1												
M. kamaka	19	2.8	3	3	2.7	2.5	2.6	2.4	2.8	2.7	2.7	2.5	3	2.8	3	2.8	2.3	0	0.1											
M. trifasciata_II	20	2.1	2.2	2.2	2.3	2.1	2.2	1.9	2.2	2.3	2.1	2.1	2.4	2.4	2.5	2.5	2	2	2.1	2										
M. senckenbergianus	21	2.7	2.8	2.8	2.5	2.3	2.6	2.4	2.8	2.9	2.7	2.5	2.8	2.7	3	3	2.5	2.5	2.5	2.5	1									
M. trifasciata_IV	22	2.6	2.6	2.6	2.5	2.4	2.5	2.2	2.8	2.9	2.5	2.4	2.6	2.5	2.6	2.6	2.5	2.5	2.5	2.5	1	1.2								
M. oktediensis	23	2.6	2.7	2.4	2.5	2.3	2.4	2.1	2.5	2.6	2.3	2.1	2.4	2.3	2.5	2.5	2.4	2.5	2.6	2.5	1.1	1.3	1							
M. goldiei_VII	24	2.6	2.7	2.5	2.5	2.3	2.4	2.1	2.5	2.6	2.3	2	2.3	2.3	2.5	2.5	2.4	2.4	2.5	2.4	0.9	1.1	0.8	0.7						
M. trifasciata_III	25	2.5	2.5	2.4	2.5	2.1	2.2	1.9	2.4	2.5	2.1	1.8	2.2	2.1	2.3	2.3	2.2	2.2	2.3	2.2	0.7	1.1	0.8	0.7	0.4					
M. goldiei_X	26	3.7	3.5	3.5	3.6	3.2	3.3	3.1	3.7	3.8	3.4	3.2	3.5	3.4	3.5	3.7	3.4	3.5	3.6	3.5	3.1	3.5	3.2	3.2	3.2	3.1				
M. goldiei_XI	27	3.9	3.7	3.8	3.7	3.6	3.5	3.2	3.9	3.9	3.6	3.4	3.7	3.6	3.9	4	3.5	3.6	3.7	3.6	3.2	3.7	3.3	3.4	3.4	3.2	0.7			
M. mubiensis	28	4	3.9	4	3.6	3.8	4	3.8	4.4	4.5	4.1	3.8	4.2	4	3.7	3.7	4.2	4.4	4.5	4.4	3.8	4.2	3.5	3.8	3.7	3.5	3.9	4.3		
M. monticola	29	4.8	4.8	4.9	4.5	4.4	4.4	4.1	4.5	4.4	4.2	4.1	4.4	4.4	4.7	4.6	4.6	4.9	5	4.9	4.6	4.5	4.6	4.4	4.4	4.4	4.6	4.9	4.7	
M. lacustris	30	4.6	4.6	4.7	4.3	4.2	4.2	3.9	4.3	4.2	4	3.9	4.2	4.2	4.6	4.4	4.4	4.7	4.8	4.7	4.4	4.3	4.5	4.2	4.2	4.2	4.5	4.7	4.6	0.2

imum p-distances of 0.5-2.2, Table VIII) and some clear colouration differences, morphological and meristic differences are minimal in most cases. The one major exception being the *M. lacunosa* and *M. etnaensis* species pair, which are the most similar genetically of the new species (p-distance of 0.5 %, Table VIII), but have the clearest morphological differences (almost completely non-overlapping gill raker counts, Table II). We argue that there are limits to when morphological/meristic traits are diagnostic and to rely solely on these traits will underestimate the total number of rainbowfish species, especially when two other datasets (molecular and colouration) provide clear separation that is typically of the degree of separation between most other closely related rainbowfish species. This argument is similar to that presented by Gill & Kemp (2002) for Indo-Pacific marine fishes who stated "an absence of difference in examined morphological characters does not overrule any differences observed in molecular or other biochemical characters and the converse also applies."

New Guinea is a relatively youthful island, which has experienced dynamic landscape alteration in relatively recent geological history (Polhemus 2007). However, uplift of mountainous areas and amalgamation of drifting island arcs were more active processes in the north, mainly due to the proximity of the colliding Australian and Pacific plates. Southern New Guinea, which for much of its recent geological past has been connected by land to northern Australia, has been a more stable platform for freshwater fish evolution, evidenced by its richer fauna. More or less continual alluvial lowland

has facilitated the widespread distribution of the ancestral "Goldiei" group lineage, setting the stage for subsequent evolution. Many "Goldiei" group members appear to be restricted to downstream portions of major river drainages, but more than any other lineage this group exhibits a remarkable capability of penetrating inland into foothill and mountainous terrain, where founder populations are subsequently divided by a variety of physical barriers, especially waterfalls and landslides. The high mountain landscape of central New Guinea remains a seemingly impenetrable barrier for freshwater fish colonisation. Indeed, no native species have been reported above about 1,800 m elevation (Allen 2007). The highest streams are generally populated by one or more gobiioid species, frequently *Oxyeleotris fimbriata* (Weber 1907). Although melanotaeniids may penetrate hundreds of kilometres inland in large river systems such as the Fly, Sepik and Mamberamo, they are rarely seen above 1,000 m elevation. The two exceptions are *M. monticola* Allen 1980, which inhabits mountainous terrain of the Kikori River system from about 790-1,600 m elevation and *M. sneideri* Allen & Hadiaty 2013 which is known from 1,050 m elevation on the Bomberai Peninsula. The Central Dividing Range, with peaks rising to more than 4,000 m, forms an effective barrier for isolating the northern and southern melanotaeniid faunas for most of the length of the island. Prior to the present study, only one rainbowfish species and one species pair has been reported from both sides of the Central Dividing Range. *Chilatherina campsi* (Whitley 1956) mainly inhabits river systems of northern Papua New Guinea, but has also been found in the central highlands in the Purari system, a southern-flowing river. *Melanotaenia iris* inhabits the Strictland River (Fly drainage), but is closely related to *M. affinis* which is otherwise mostly widespread across northern Papua New Guinea drainages (Unmack et al. 2013). However, the Birds Neck region presents an entirely different scenario with the high mountains transitioning to lower ranges. It seems likely that the ancestral lineage of the Birds Neck "Goldiei" group penetrated northern drainages via the Omba-Woromi corridor (named after the Omba River in the south and Woromi Village that lies in the middle of the northern portion), which is shown by the dotted lines in Fig. 1. Although the corridor is bordered by mountain ranges that rise to 1,300-1,400 m, it forms a low-elevation passage, effectively linking southern and northern drainages. The Omba River (Urama River on some maps) forms the southern portion, winding for 165 km to Lake Yamur, which is only 33 m above sea level. The head waters of this system are difficult to distinguish from those of a northern flowing river (name unavailable), being nearly conjoined at an approximate elevation of only 160 m.

Allen (1998) described *Pelangia mbutaensis* as a new genus and species of rainbowfish from the same locality (Lake Mbuta) as *M. lacunosa*. Despite its southern distribution, the species appears to be closely related to the genus *Glossolepis* from northern drainages based on their morphological similarity. Perhaps the ancestor to *Pelangia* gained access via a similar connection early in the colonisation of this region by rainbowfishes.

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APPENDIX

Fig. 1a-b. Aquarium photographs of (a) *Melanotaenia etnaensis*, male, approximately 60 mm SL and (b) female approximately 55 mm, Sungai Pama, West Papua Province, Indonesia. Photos by H. Bleher.

Figs 2. Aquarium photograph of *Melanotaenia etnaensis*, adult male, approximately 100 mm SL, vicinity of Etna Bay, West Papua Province, Indonesia. Photo H. Bleher.